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# MEDDELELSER

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# KOMMISSIONEN FOR HAVUNDERSØGELSER

SERIE: HYDROGRAFI · BIND I

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NR. 9. J. N. NIELSEN: CONTRIBUTION TO THE HYDROGRAPHY OF THE NORTH-EASTERN PART OF THE ATLANTIC OCEAN. WITH 3 PLATES.

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KØBENHAVN
I KOMMISSION HOS C. A. REITZEL
BIANCO LUNOS BOGTRYKKERI
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MEDDELELSER FRA KOMMISSIONEN FOR HAVUNDERSØGELSER
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# CONTRIBUTION TO THE HYDROGRAPHY OF THE NORTH-EASTERN PART OF THE ATLANTIC OCEAN

BY

J. N. NIELSEN

WITH 3 PLATES

KØBENHAVN
I KOMMISSION HOS C. A. REITZEL
BIANCO LUNOS BOGTRYKKERI
1907

# Material of Observation.

THE material of observation, on which this paper is based and which was taken during the cruises of the "Thor" in the summer 1904 and 1905 in the north-eastern part of the Atlantic Ocean (south of Iceland-Faroes and west of the British islands) is noted in the following tables.

In Table I are found the observations on the Stations; $m$ means the depth measured in meters, $t°$ the corrected temperature in this depth, $S\,‰$ means the salinity in pro mille and $\sigma_t = 1000\ (s_t - 1)$, where $s_t$ is the specific gravity calculated by the observed temperature and salinity at a pressure of 1 atmosphere.

In Table II are noted the temperature and salinity of the samples of surface water which were taken between the Stations.

**Table I.**

**Station 37** 1904 V 11
61°06′ N Lat. 8°30′ W Long.
112 m.

| $m$ | $t°$ | $S\,‰$ | $\sigma_t$ |
|---|---|---|---|
| 0 | 7·78 | 35·28 | 27·54 |
| 10 | 72 | — | — |
| 25 | 62 | 26 | 56 |
| 50 | 62 | 26 | 56 |
| 75 | 62 | 26 | 56 |
| 110 | 62 | 26 | 56 |

**Station 38** 1904 V 12
61°08′ N Lat. 9°28′ W Long.
645 m.

| $m$ | $t°$ | $S\,‰$ | $\sigma_t$ |
|---|---|---|---|
| 0 | 8·20 | 35·30 | 27·50 |
| 25 | 19 | 29 | 49 |
| 50 | 16 | 28 | 49 |
| 100 | 16 | 28 | 49 |
| 200 | 06 | 26 | 49 |
| 330 | 7·93 | 26 | 51 |
| 400 | 88 | 26 | 52 |
| 500 | 86 | 26 | 52 |
| 640 | 72 | 26 | 54 |

**Station 39** 1904 V 23
62°17′ N Lat. 14°18′ W Long.
1500 m. (no bottom)

| $m$ | $t°$ | $S\,‰$ | $\sigma_t$ |
|---|---|---|---|
| 0 | 8·12 | 35·29 | 27·50 |
| 100 | 7·94 | 27 | 52 |
| 200 | 81 | 26 | 53 |
| 400 | 75 | 26 | 54 |
| 800 | 7·08 | 35·21 | 27·60 |
| 1000 | 5·60 | 15 | 74 |
| 1200 | 4·11 | 06 | 84 |
| 1500 | 2·82 | 03 | 91 |

**Station 40** 1904 V 24
62°47′ N Lat. 15°03′ W Long.
1800—2000 m.

| $m$ | $t°$ | $S\,‰$ | $\sigma_t$ |
|---|---|---|---|
| 0 | 7·92 | 35·27 | 27·52 |
| 50 | 91 | 26 | 51 |
| 100 | 83 | 25 | 51 |
| 200 | 73 | 25 | 52 |
| 400 | 63 | 25 | 54 |
| 800 | 50 | 25 | 56 |
| 1200 | 5·47 | 10 | 72 |

**Station 41** 1904 V 24
63°14′ N Lat. 15°36′ W Long.

| $m$ | $t°$ | $S\,‰$ | $\sigma_t$ |
|---|---|---|---|
| 0 | 8·01 | 35·23 | 27·47 |
| 25 | 7·90 | 23 | 48 |
| 100 | 67 | 25 | 53 |

**Station 42** 1904 V 24
63°22′ N Lat. 15°52′ W Long.
1051 m.

| $m$ | $t°$ | $S\,‰$ | $\sigma_t$ |
|---|---|---|---|
| 0 | 8·20 | 35·24 | 27·45 |
| 25 | 7·89 | 23 | 49 |
| 100 | 86 | 23 | 49 |
| 400 | 55 | 23 | 54 |
| 750 | 6·06 | 16 | 68 |
| 1000 | 4·70 | 10 | 81 |

**Station 43** 1904 V 24
63°31′ N Lat. 16°06′ W Long.
116 m.

| $m$ | $t°$ | $S\,‰$ | $\sigma_t$ |
|---|---|---|---|
| 0 | 8·00 | 35·16 | 27·41 |
| 5 | 7·81 | 15 | 43 |
| 10 | 49 | — | — |
| 25 | 44 | 12 | 46 |
| 100 | 24 | 19 | 55 |

**Station 44** 1904 V 24
63°39′ N Lat. 16°20′5 W Long.
110 m.

| $m$ | $t°$ | $S\,‰$ | $\sigma_t$ |
|---|---|---|---|
| 0 | 7·72 | 35·01 | 27·34 |
| 10 | 71 | 03 | 35 |
| 25 | 46 | 07 | 42 |
| 100 | 19 | 16 | 53 |

**Station 45** 1904 V 24
63°51′ N Lat. 16°25′ W Long.
60 m.

| $m$ | $t°$ | $S\,‰$ | $\sigma_t$ |
|---|---|---|---|
| 0 | 7·39 | 34·95 | 27·34 |
| 57 | 6·84 | 35·11 | 55 |

**Station 63** 1904 VII 8
63°32′ N Lat. 21°30′ W Long.
106 m.

| $m$ | $t°$ | $S\,‰$ | $\sigma_t$ |
|---|---|---|---|
| 0 | 10·89 | 35·14 | 26·92 |
| 10 | 52 | 14 | 99 |
| 25 | 9·77 | 14 | 27·12 |
| 35 | 8·71 | 14 | 30 |
| 50 | 06 | 14 | 40 |
| 75 | 7·88 | 16 | 44 |
| 104 | 85 | 16 | 44 |

**Station 64** 1904 VII 9
63°08′ N Lat. 21°30′ W Long.
662 m.

| $m$ | $t°$ | $S\,‰$ | $\sigma_t$ |
|---|---|---|---|
| 0 | 10·44 | 35·16 | 27·02 |
| 10 | 40 | — | — |
| 25 | 18 | 16 | 07 |
| 35 | 9·41 | — | — |
| 40 | 8·45 | — | — |
| 50 | 07 | 16 | 41 |
| 100 | 7·67 | 19 | 49 |
| 200 | 41 | 19 | 53 |
| 300 | 27 | 19 | 55 |
| 400 | 15 | 19 | 57 |
| 500 | 03 | 18 | 58 |
| 600 | 6·61 | 17 | 63 |
| 655 | 16 | 13 | 65 |

**Station 65** 1904 VII 11
61°43′ N Lat. 17°08′ W Long.
2000 m. (no bottom)

| $m$ | $t°$ | $S\,‰$ | $\sigma_t$ |
|---|---|---|---|
| 0 | 11·24 | 35·21 | 26·91 |
| 35 | 10·41 | — | — |
| 50 | 8·80 | 22 | 27·35 |
| 100 | 35 | 25 | 43 |
| 200 | 7·97 | 23 | 47 |
| 400 | 74 | 23 | 51 |
| 800 | 06 | 16 | 55 |
| 1200 | 5·49 | 07 | 69 |
| 1600 | 3·70 | 34·94 | 79 |

| $m$ | $t°$ | $S$ ‰ | $\sigma_t$ |
|---|---|---|---|
| **Station 66** 1904 VII 11 | | | |
| 62°45′ N Lat. 18°40′ W Long. | | | |
| 1340 m. | | | |
| 0 | 11·25 | 35·13 | 26·84 |
| 50 | 8·8 | 19 | 27·32 |
| 100 | 7·8 | 19 | 47 |
| 400 | 3 | 21 | 55 |
| 850 | 5·88 | 13 | 70 |
| 1000 | 08 | 08 | 75 |
| 1300 | 4·31 | 07 | 83 |
| **Station 67** 1904 VII 12 | | | |
| 63°16′ N Lat. 19°17′ W Long. | | | |
| 765 m. | | | |
| 0 | 11·43 | 35·03 | 26·73 |
| 25 | 10·09 | 14 | 27·07 |
| 35 | 9·13 | 16 | 25 |
| 50 | 8·14 | 21 | 44 |
| 100 | 7·77 | 21 | 49 |
| 200 | 67 | 21 | 51 |
| 400 | 53 | 21 | 53 |
| 600 | 30 | 21 | 57 |
| 700 | 30 | 21 | 57 |
| **Station 114** 1904 VIII 31 | | | |
| 63°25′ N Lat. 20°03′ W Long. | | | |
| 150 m. | | | |
| 0 | 11·70 | 34·49 | 26·26 |
| 10 | 70 | 51 | 28 |
| 20 | 55 | 65 | 42 |
| 30 | 31 | 92 | 67 |
| 40 | 31 | 35·03 | 76 |
| 45 | 10·95 | 07 | 86 |
| 47·5 | 10 | 01 | 97 |
| 50 | 9·78 | 04 | 27·04 |
| 55 | 17 | 14 | 22 |
| 60 | 8·42 | 19 | 38 |
| 75 | 7·97 | 22 | 47 |
| 100 | 74 | 22 | 50 |
| 145 | 69 | 22 | 51 |
| **Station 115** 1904 IX 3 | | | |
| 60°40′ N Lat. 9°20′ W Long. | | | |
| 130 m. | | | |
| 0 | 10·72 | 35·24 | 27·03 |
| 10 | 50 | 25 | 07 |
| 20 | 38 | 25 | 09 |
| 30 | 30 | 26 | 13 |
| 40 | 07 | — | — |
| 50 | 03 | 30 | 20 |
| 75 | 9·88 | 30 | 23 |
| 100 | 76 | 30 | 25 |
| 125 | 71 | 30 | 26 |

| $m$ | $t°$ | $S$ ‰ | $\sigma_t$ |
|---|---|---|---|
| **Station 45** 1905 V 23 | | | |
| 64°02′ N Lat. 15°40′ W Long. | | | |
| 71 m. | | | |
| 0 | 7·81 | 35·01 | 27·34 |
| 10 | 42 | 01 | 39 |
| 25 | 6·99 | 16 | 56 |
| 50 | 98 | 16 | 56 |
| 69 | 98 | 16 | 56 |
| **Station 46** 1905 V 23 | | | |
| 63°51′ N Lat. 16°25′ W Long. | | | |
| 60 m. | | | |
| 0 | 7·51 | 34·81 | 27·22 |
| 10 | 14 | 99 | 41 |
| 25 | 6·87 | 35·14 | 57 |
| 58 | 90 | 16 | 57 |
| **Station 47** 1905 V 25 | | | |
| 63°36′ N Lat. 16°29′ W Long. | | | |
| 95 m. | | | |
| 0 | 7·66 | 34·87 | 27·24 |
| 10 | 71 | 88 | 24 |
| 25 | 60 | 97 | 34 |
| 50 | 11 | 35·16 | 55 |
| 90 | 02 | 16 | 56 |
| **Station 48** 1905 V 25 | | | |
| 63°21′ N Lat. 16°22′ W Long. | | | |
| 500 m. | | | |
| 0 | 7·71 | 35·14 | 27·44 |
| 10 | 77 | 14 | 43 |
| 25 | 78 | 15 | 44 |
| 50 | 70 | 15 | 45 |
| 100 | 45 | 20 | 53 |
| 300 | 25 | 21 | 57 |
| 490 | 05 | 20 | 59 |
| **Station 49** 1905 V 26 | | | |
| 63°07′ N Lat. 16°12′ W Long. | | | |
| 1475 m. | | | |
| 0 | 8·05 | 35·20 | 27·44 |
| 50 | 00 | 21 | 46 |
| 800 | 7·18 | 19 | 56 |
| 1000 | 5·05 | 08 | 75 |
| 1400 | 3·49 | 06 | 90 |
| **Station 50** 1905 V 28 | | | |
| 61°50′ N Lat. 11°38′ W Long. | | | |
| 1100 m. | | | |
| 0 | 8·62 | 35·28 | 27·42 |
| 50 | 47 | 28 | 44 |
| 100 | 33 | 27 | 45 |
| 200 | 00 | 27 | 50 |
| 400 | 7·79 | 26 | 53 |
| 600 | 48 | 25 | 56 |
| 800 | 09 | 23 | 61 |
| 950 | 6·21 | 17 | 68 |
| 1090 | 3·07 | 08 | 96 |

| $m$ | $t°$ | $S$ ‰ | $\sigma_t$ |
|---|---|---|---|
| **Station 51** 1905 V 29 | | | |
| 60°43′ N Lat. 10°42′ W Long. | | | |
| 203 m. | | | |
| 0 | 8·61 | 35·29 | 27·43 |
| 10 | 56 | 28 | 43 |
| 25 | 42 | 27 | 44 |
| 50 | 21 | 27 | 47 |
| 100 | 02 | 28 | 51 |
| 200 | 03 | 28 | 51 |
| **Station 52** 1905 V 30 | | | |
| 59°49′ N Lat. 8°58′ W Long. | | | |
| 1155 m. | | | |
| 0 | 9·19 | 35·30 | 27·34 |
| 25 | 13 | 30 | 35 |
| 50 | 8·70 | 30 | 42 |
| 100 | 47 | 30 | 45 |
| 200 | 40 | 29 | 45 |
| 400 | 41 | 30 | 46 |
| 600 | 05 | 26 | 49 |
| 1000 | 6·99 | 24 | 63 |
| 1150 | 60 | 21 | 66 |
| **Station 53** 1905 V 30 | | | |
| 59°15′ N Lat. 7°23′ W Long. | | | |
| 420 m. | | | |
| 0 | 9·87 | 35·41 | 27·32 |
| 200 | 18 | 41 | 44 |
| 400 | 8·95 | 39 | 45 |
| 59°17′ N Lat. 7°29′ W Long. | | | |
| 895 | 7·93 | — | — |
| **Station 54** 1905 V 31 | | | |
| 58°45′ N Lat. 6°26′ W Long. | | | |
| 100 m. | | | |
| 0 | 9·91 | 35·37 | 27·28 |
| 50 | 8·74 | 35 | 45 |
| 90 | 63 | 36 | 48 |
| **Station 55** 1905 VI 6 | | | |
| 58°02′ N Lat. 8°00′ W Long. | | | |
| 116 m. | | | |
| 0 | 9·83 | 35·25 | 27·19 |
| 25 | 15 | 21 | 29 |
| 55 | 8·79 | 17 | 31 |
| 110 | 67 | 19 | 34 |
| **Station 56** 1905 VI 6 | | | |
| 57°46′ N Lat. 9°01′ W Long. | | | |
| 144 m. | | | |
| 0 | 10·53 | 35·40 | 27·20 |
| 25 | 39 | — | — |
| 50 | 9·81 | 37 | 30 |
| 75 | 8·84 | 37 | 46 |
| 100 | 42 | 32 | 47 |
| 140 | 37 | 32 | 48 |

| $m$ | $t°$ | $S$ ‰ | $\sigma_t$ |
|---|---|---|---|
| **Station 57** 1905 VI 7 | | | |
| 57°45′ N Lat. 9°57′ W Long. | | | |
| 1150 m. | | | |
| 0 | 10·63 | 35·39 | 27·16 |
| 50 | 9·93 | 39 | 29 |
| 100 | 23 | 39 | 40 |
| 500 | 8·78 | 34 | 43 |
| 1100 | 10 | 27 | 48 |
| **Station 58** 1905 VI 7 | | | |
| 57°47′ N Lat. 11°34′ W Long. | | | |
| 1985 m. | | | |
| 0 | 10·53 | 35·31 | 27·12 |
| 25 | 30 | — | — |
| 50 | 9·78 | 31 | 25 |
| 100 | 26 | 39 | 40 |
| 800 | 8·31 | 31 | 49 |
| 1100 | 6·85 | 19 | 61 |
| 1500 | 4·74 | 08 | 79 |
| 1900[1] | 3·52 | 01 | 87 |

[1] Under the hauling up the water-bottle was stopped in about 20 min. in a depth of 1820 meters.

| | | | |
|---|---|---|---|
| **Station 59** 1905 VI 10 | | | |
| 56°56′ N Lat. 9°22′ W Long. | | | |
| 1390 m. | | | |
| 0 | 11·20 | 35·42 | 27·09 |
| 25 | 10·80 | — | — |
| 50 | 33 | 39 | 22 |
| 75 | 14 | — | — |
| 100 | 9·37 | 42 | 41 |
| 500 | 00 | 39 | 44 |
| 800 | 8·50 | 41 | 54 |
| 1000 | 7·80 | 28 | 54 |
| 1100 | 6·75 | 25 | 66 |
| 1380 | 5·38 | 12 | 74 |
| **Station 60** 1905 VI 11 | | | |
| 56°00′ N Lat. 9°57′ W Long. | | | |
| 2040 m. | | | |
| 0 | 11·93 | 35·43 | 26·95 |
| 25 | 10·85 | — | — |
| 50 | 49 | 39 | 27·19 |
| 75 | 9·75 | — | — |
| 100 | 54 | 41 | 37 |
| 500 | 10 | 38 | 42 |
| 800 | 8·67 | 35 | 46 |
| 1000 | 7·78 | 32 | 57 |
| 1100 | 6·95 | 27 | 66 |
| 1500 | 4·50 | 07 | 81 |
| 1900 | 3·48 | 34·99 | 85 |

| $m$ | $t°$ | $S$ ‰ | $\sigma_t$ |
|---|---|---|---|
| **Station 61** 1905 VI 12 | | | |
| 55°04′ N Lat. 9°58′ W Long. | | | |
| 115 m. | | | |
| 0 | 12·40 | 35·37 | 26·82 |
| 10 | 12 | — | — |
| 25 | 11·56 | 35 | 97 |
| 37 | 10·56 | — | — |
| 50 | 16 | 38 | 27·24 |
| 75 | 9·90 | 39 | 30 |
| 110 | 77 | 39 | 32 |
| **Station 62** 1905 VI 12 | | | |
| 54°18′ N Lat. 10°15′ W Long. | | | |
| 101 m. | | | |
| 0 | 12·12 | 34·97 | 26·57 |
| 25 | 11·50 | 35·01 | 72 |
| 50 | 10·61 | 17 | 27·00 |
| 98 | 12 | 26 | 16 |
| **Station 63** 1905 VI 13 | | | |
| 53°06′ N Lat. 10°47′ W Long. | | | |
| 130 m. | | | |
| 0 | 13·36 | 35 34 | 26·60 |
| 25 | 12·45 | 32 | 76 |
| 30 | 11·65 | 30 | 91 |
| 37 | 10·68 | 37 | 27·15 |
| 50 | 00 | 43 | 30 |
| 87 | 9·37 | 43 | 41 |
| 125 | 33 | 43 | 41 |
| **Station 64** 1905 VI 13 | | | |
| 52°06′ N Lat. 11°10′ W Long. | | | |
| 144 m. | | | |
| 0 | 14·11 | 35·52 | 26·58 |
| 25 | 11·94 | 50 | 27·01 |
| 37 | 39 | — | — |
| 50 | 10·48 | 46 | 24 |
| 100 | 13 | 47 | 31 |
| 142 | 02 | 47 | 33 |
| **Station 65** 1905 VI 15 | | | |
| 51°00′ N Lat. 11°43′ W Long. | | | |
| 1350 m. | | | |
| 0 | 13·79 | 35·46 | 26·60 |
| 25 | 20 | 47 | 73 |
| 37 | 12·35 | — | — |
| 50 | 11·29 | 43 | 27·07 |
| 100 | 10·52 | 44 | 22 |
| 400 | 17 | 46 | 31 |
| 800 | 9·40 | 49 | 45 |
| 1000 | 8·58 | 53 | 63 |
| 1100 | 21 | 52 | 67 |
| 1300 | 6·85 | 34 | 73 |

| $m$ | $t°$ | $S$ ‰ | $\sigma_t$ |
|---|---|---|---|
| **Station 66** 1905 VI 18 | | | |
| 51°24′ N Lat. 8°18′ W Long. | | | |
| 95 m. | | | |
| 0 | 14·25 | 35·23 | 26·33 |
| 25 | 03 | 21 | 36 |
| 37 | 9·64 | — | — |
| 50 | 64 | 26 | 27·24 |
| 90 | 64 | 23 | 25 |
| **Station 67** 1905 VI 19 | | | |
| 50°19′ N Lat. 8°30′ W Long. | | | |
| 120 m. | | | |
| 0 | 14·22 | 35·37 | 26·45 |
| 25 | 18 | 37 | 46 |
| 37 | 11·99 | — | — |
| 50 | 10·85 | 34 | 27·08 |
| 115 | 9·88 | 31 | 24 |
| **Station 68** 1905 VI 19 | | | |
| 49°14′ N Lat. 8°45′ W Long. | | | |
| 95 m. | | | |
| 0 | 14·05 | 35·39 | 26·50 |
| 50 | 10 23 | 32 | 27·18 |
| 90 | 22 | 32 | 18 |
| **Station 69** 1905 VI 21 | | | |
| 47°47′ N Lat. 8°00′ W Long. | | | |
| 1012 m. | | | |
| 0 | 14·40 | 35·53 | 26·54 |
| 25 | 13·00 | 53 | 83 |
| 50 | 12·82 | 53 | 87 |
| 100 | 11·70 | 56 | 27·10 |
| 200 | 06 | 59 | 24 |
| 400 | 10·77 | 58 | 29 |
| 600 | 47 | 60 | 36 |
| 800 | 00 | 61 | 45 |
| 1000 | 9·47 | 64 | 56 |
| **Station 70** 1905 VI 25 | | | |
| 49°53′ N Lat. 11°51′ W Long. | | | |
| 1180 m. | | | |
| 0 | 15·10 | 35·52 | 26·37 |
| 50 | 13·82 | 50 | 63 |
| 75 | 11·52 | — | — |
| 100 | 10·92 | 44 | 27·14 |
| 250 | 33 | 44 | 25 |
| 400 | 00 | 44 | 31 |
| 800 | 9·35 | 48 | 45 |
| 1000 | 8·81 | 55 | 60 |
| 1150 | 10 | 53 | 70 |
| **Station 71** 1905 VI 27 | | | |
| 50°02′ N Lat. 6°20 W′ Long. | | | |
| 86 m. | | | |
| 0 | 14·74 | 35·26 | 26·25 |
| 45 | 12·21 | 28 | 78 |
| 85 | 11·82 | 26 | 84 |

| $m$ | $t°$ | $S$ ‰ | $\sigma_t$ |
|---|---|---|---|
| **Station 72** 1905 VI 27 | | | |
| 50°15′ N Lat. 4°19′ W Long. | | | |
| 50 m. | | | |
| 0 | 15·10 | 35·21 | 26·14 |
| 25 | 12·01 | 35 | 88 |
| 48 | 11·63 | 39 | 98 |
| **Station 73** 1905 VI 29 | | | |
| 50°32′ N Lat. 1°05′ W Long. | | | |
| 25 m. | | | |
| 0 | 15·21 | 34·92 | 25·88 |
| 10 | 14 | 90 | 89 |
| 24 | 13 | 94 | 92 |
| **Station 74** 1905 VI 30 | | | |
| 50°43′ N Lat. 0°43′ E Long. | | | |
| 41 m. | | | |
| 0 | 13·69 | 35·19 | 26·42 |
| 20 | 27 | 21 | 52 |
| 40 | 03 | 21 | 57 |
| **Station 119** 1905 VIII 27 | | | |
| 64°33′ N Lat. 13°50′ W Long. | | | |
| 88 m. | | | |
| 0 | 7·80 | 34·20 | 26·69 |
| 10 | 6·98 | 22 | 82 |
| 25 | 81 | 23 | 87 |
| 50 | 21 | 38 | 27·06 |
| 85 | 12 | 42 | 09 |
| **Station 120** 1905 VIII 27 | | | |
| 63°42′ N Lat. 13°02′ W Long. | | | |
| 659 m. | | | |
| 0 | 11·02 | 35·08 | 26·86 |
| 25 | 10·65 | 10 | 94 |
| 50 | 9·41 | 17 | 27·21 |
| 100 | 8·22 | 23 | 44 |
| 200 | 7·80 | 25 | 51 |
| 400 | 64 | 25 | 53 |
| 500 | 47 | 23 | 55 |
| 600 | 5·22 | 14 | 78 |
| 650 | 3·84 | 07 | 88 |
| **Station 121** 1905 VIII 28 | | | |
| 62°36′ N Lat. 12°05′ W Long. | | | |
| 721 m. | | | |
| 0 | 11·22 | 35·16 | 26·87 |
| 10 | 18 | 16 | 88 |
| 25 | 10·42 | 16 | 27·02 |
| 37 | 08 | — | — |
| 50 | 9·30 | 22 | 26 |
| 75 | 8·58 | — | — |
| 100 | 20 | 25 | 45 |
| 200 | 7·81 | 25 | 51 |
| 400 | 57 | 25 | 55 |
| 500 | 39 | 23 | 56 |
| 600 | 6·59 | 17 | 63 |
| 650 | 5·18 | 14 | 79 |
| 710 | 1·75 | 03 | 28·04 |

| $m$ | $t°$ | $S$ ‰ | $\sigma_t$ |
|---|---|---|---|
| **Station 122** 1905 VIII 29 | | | |
| 61°20′ N Lat. 11°00′ W Long. | | | |
| 1300 m. | | | |
| 0 | 11·61 | 35·16 | 26·79 |
| 25 | 45 | 16 | 82 |
| 50 | 10·16 | 19 | 27·09 |
| 75 | 9·28 | 20 | 25 |
| 100 | 8·67 | 23 | 37 |
| 200 | 23 | 25 | 46 |
| 400 | 7·96 | 25 | 49 |
| 600 | 76 | 25 | 52 |
| 800 | 43 | 21 | 54 |
| 1000 | 6·90 | 17 | 59 |
| 1100 | 5·73 | 14 | 72 |
| 1200 | 3·92 | 10 | 90 |
| 1300 | 65 | 08 | 91 |
| **Station 123** 1905 VIII 29 | | | |
| 60°00′ N Lat. 10°35′ W Long. | | | |
| 1050 m. | | | |
| 0 | 12·44 | 35·21 | 26·69 |
| 25 | 40 | 21 | 69 |
| 50 | 10·96 | 22 | 97 |
| 75 | 9·22 | — | — |
| 100 | 8·57 | 23 | 27·38 |
| 150 | 83 | — | — |
| 200 | 68 | 33 | 45 |
| 400 | 34 | 31 | 48 |
| 600 | 26 | 30 | 49 |
| 800 | 7·76 | 25 | 52 |
| 1000 | 37 | 23 | 57 |
| **Station 124** 1905 VIII 30 | | | |
| 58°53′ N Lat. 10°15′ W Long. | | | |
| about 1850 m. | | | |
| 0 | 13·40 | 35·29 | 26·55 |
| 10 | 36 | — | — |
| 25 | 32 | 31 | 58 |
| 50 | 12·00 | 30 | 84 |
| 75 | 9·42 | — | — |
| 100 | 16 | 34 | 27·37 |
| 400 | 8·48 | 32 | 46 |
| 800 | 01 | 30 | 53 |
| 1000 | 7·45 | 28 | 59 |
| 1200 | 6·30 | 21 | 70 |
| 1560 | 4·26 | 07 | 83 |
| **Station 125** 1905 VIII 31 | | | |
| 57°46′ N Lat. 9°55′ W Long. | | | |
| 1120 m. | | | |
| 0 | 13·50 | 35·30 | 26·54 |
| 10 | 45 | — | — |
| 25 | 42 | 28 | 54 |

| $m$ | $t°$ | $S$ ‰ | $\sigma_t$ |
|---|---|---|---|
| 50 | 11·25 | 35·39 | 27·05 |
| 100 | 9·61 | 41 | 36 |
| 400 | 07 | 40 | 44 |
| 800 | 8·56 | 34 | 47 |
| 1100 | 7·51 | 25 | 55 |

| $m$ | $t°$ | $S$ ‰ | $\sigma_t$ |
|---|---|---|---|
| Station **126** 1905 IX 2 58°42′ N Lat. 6°13′ W Long. 110 m. | | | |
| 0 | 13·03 | 35·14 | 26·51 |
| 25 | 01 | 16 | 53 |
| 50 | 12·64 | 17 | 62 |

| $m$ | $t°$ | $S$ ‰ | $\sigma_t$ |
|---|---|---|---|
| 75 | 11·63 | 35·19 | 26·82 |
| 100 | 10·67 | 26 | 27·06 |
| Station **127** 1905 IX 2 58°43′ N Lat. 3°30′ W Long. 75 m. | | | |
| 0 | 12·40 | 35·03 | 26·55 |

| $m$ | $t°$ | $S$ ‰ | $\sigma_t$ |
|---|---|---|---|
| 10 | 12·42 | — | — |
| 25 | 42 | 35·03 | 26·55 |
| 50 | 42 | — | — |
| 70 | 42 | 03 | 55 |

## Table II.

| Time | N Lat. | W Long. | Surf. temp. | Surf. salin. |
|---|---|---|---|---|
| 1904 | | | | |
| IV 13 | 59°27′ | 5°06′ | 8·18 | 35·34 |
| » » | 43′ | 37′ | 48 | 41 |
| » » | 58′ | 6°16′ | 50 | 35 |
| » » | 60°13′ | 55′ | 7·75 | 32 |
| » » | 29′ | 7°33′ | 8·15 | 30 |
| » 14 | 55′ | 8°35′ | 7·82 | 28 |
| » » | 61°13′ | 9°20′ | 92 | 28 |
| » » | 17′ | 28′ | 8·02 | 28 |
| » » | 29′ | 46′ | 14 | 30 |
| » » | 51′ | 10°10′ | 22 | 28 |
| » » | 62°09′ | 30′ | 20 | 28 |
| » » | 25′ | 11°03′ | 7·98 | 28 |
| » » | 45′ | 36′ | 6 | 26 |
| » 15 | 63°04′ | 12°08′ | 35 | 19 |
| » » | 22′ | 39′ | 32 | 19 |
| » » | 41′ | 13°12′ | 65 | 25 |
| » » | 46′ | 21′ | 32 | 25 |
| » » | 57′ | 45′ | 11 | 21 |
| » » | 64°06′5 | 59′ | 6·82 | 21 |
| » » | 09′ | 14°03′ | 07 | 23 |
| » » | 18′ | 12′ | 74 | 21 |
| » » | 20′5 | 15′ | 75 | 23 |
| » » | 23′ | 20′ | 4·00 | 34·34 |
| » » | 24′ | 22′5 | 2·38 | 49 |
| » » | 21′5 | 27′5 | 95 | — |
| » » | 18′ | 33′ | 6·40 | 35·16 |
| » » | 11′ | 49′ | 3·20 | 34·34 |
| » 16 | 06′ | 15°13′ | 4·9 | 67 |
| » » | 01′ | 36′ | 5·9 | 94 |
| » » | 63°56′ | 16°00′ | 6·75 | 35·16 |
| » » | 51′ | 22′ | 25 | 07 |
| » » | 50′ | 25′ | 5·62 | 34·49 |
| » » | 47′5 | 45′ | 6·15 | — |
| » » | 42′ | 17°03′ | 70 | 35·12 |
| » » | 36′5 | 22′ | 70 | 08 |
| » » | 40′ | 35′ | 25 | 34·18 |
| » » | 25′5 | 18°00′ | 40 | 36 |
| » 17 | 22′5 | 22′ | 75 | 97 |
| » » | 20′ | 44′ | 7·25 | 35·16 |

| Time | N Lat. | W Long. | Surf. temp. | Surf. salin. |
|---|---|---|---|---|
| 1904 | | | | |
| IV 17 | 63°22′5 | 19°06′ | 6·20 | 34·78 |
| » » | 23′ | 28′ | 50 | 97 |
| » » | 24′ | 50′ | 88 | 35·14 |
| » » | 26′5 | 20°11′5 | 55 | 05 |
| » 19 | 30′ | 52′ | 35 | 12 |
| » » | 36′ | 21°26′ | 70 | 16 |
| » » | 44′ | 22°36′ | 25 | 34·94 |
| » 20 | 64°08′ | 47′ | 4·92 | 72 |
| V 11 | 61°52′ | 7°04′ | 6·13 | 35·19 |
| » 12 | 13′ | 9°07′ | 8·02 | 28 |
| » » | 17′ | 8°48′ | 7·95 | 26 |
| » 13 | 22′ | 27′ | 8·00 | 28 |
| » » | 25′ | 05′ | 7·74 | 25 |
| » » | 29′ | 7°45′ | 61 | 25 |
| » » | 33′ | 24′ | 35 | 26 |
| » » | 38′ | 03′ | 6·92 | 21 |
| » 16 | 62°05′5 | 4°10′ | 81 | 25 |
| » » | 61°59′ | 38′ | 7·45 | 23 |
| » 17 | 52′ | 5°05′ | 31 | 23 |
| » » | 44′ | 32′ | 14 | 25 |
| » » | 36′ | 6°00′ | 6·85 | 16 |
| » » | 29′ | 28′ | 7·02 | 21 |
| » 21 | 53′ | 8°04′ | 31 | 21 |
| » 22 | 41′ | 24′ | 8·00 | 28 |
| » » | 30′ | 47′ | 28 | 30 |
| » » | 19′ | 9°07′ | 55 | 29 |
| » » | 19′ | 10°26′ | 50 | 29 |
| » 23 | 23′ | 11°21′ | 40 | 28 |
| » » | 26′ | 12°13′ | 46 | 30 |
| » » | 29′ | 13°06′ | 17 | 25 |
| » » | 58′ | 50′ | 03 | 25 |
| » » | 62°17′ | 14°18′ | 12 | 29 |
| » » | 38′ | 48′ | 05 | 29 |
| » 24 | 47′ | 15°03′ | 7·92 | 27 |
| » » | 56′ | 15′ | 8·04 | 24 |
| » » | 63°05′ | 28′ | 19 | 25 |
| » » | 14′ | 36′ | 02 | 23 |
| » » | 19′5 | 45′ | 15 | 25 |
| » » | 22′ | 52′ | 19 | 24 |

| Time | N Lat. | W Long. | Surf. temp. | Surf. salin. |
|---|---|---|---|---|
| 1904 | | | | |
| V 24 | 63°26′ | 16°00′ | 8·04 | 35·19 |
| » » | 31′ | 06′ | 00 | 16 |
| » » | 35′ | 11′ | 7·79 | 11 |
| » » | 39′ | 20′ | 72 | 01 |
| » » | 44′ | 25′ | 49 | 01 |
| » » | 51′ | 25′ | 39 | 34·95 |
| » 27 | 64°19′5 | 14°33′ | 5·16 | 33·91 |
| VII 7 | 07′ | 22°39′ | 10·70 | 33·82 |
| » 8 | 63°56′ | 47′ | 9·21 | 34·54 |
| » » | 47′5 | 44′ | 10·78 | 32·75 |
| » » | 43′5 | 22′ | 48 | 33·39 |
| » » | 40′ | 05′ | 50 | 34·34 |
| » » | 36′ | 21°48′ | 50 | 35·01 |
| » » | 32′ | 31′ | 48 | 16 |
| » » | 32′ | 30′ | 90 | 14 |
| » » | 18′ | 30′ | 61 | 16 |
| » » | 11′ | 30′ | 48 | — |
| » 9 | 08′ | 30′ | 45 | 16 |
| » » | 62°58′ | 04′ | 11·25 | 17 |
| » » | 44′ | 20°44′ | 27 | 17 |
| » » | 33′ | 29′ | 32 | 21 |
| » » | 20′ | 12′ | 10·95 | 25 |
| » » | 08′ | 19°55′ | 11·20 | 23 |
| » 10 | 61°53′ | 35′ | 08 | 21 |
| » » | 40′ | 18′ | 10·96 | 19 |
| » » | 34′ | 05′ | 11·05 | 20 |
| » » | 33′ | 18°11′ | 50 | 20 |
| » » | 31′ | 17°39′ | 23 | 17 |
| » 11 | 43′ | 08′ | 25 | 21 |
| » » | 55′ | 30′ | 42 | 20 |
| » » | 62°07′ | 50′ | 34 | 17 |
| » » | 18′ | 18°12′ | 22 | 20 |
| » » | 32′ | 26′ | 47 | 12 |
| » » | 45′ | 40′ | 25 | 13 |
| » 12 | 58′ | 57′ | 39 | 14 |
| » » | 63°11′ | 19°11′ | 20 | 07 |
| » » | 16′ | 17′ | 43 | 03 |
| » 14 | 33′ | 21°23′ | 20 | 14 |
| » » | 45′ | 20′ | 80 | 34·38 |

| Time | N Lat. | W Long. | Surf. temp. | Surf. salin. |
|---|---|---|---|---|
| 1904 | | | | |
| VII 14 | 63°46′ | 21°20′ | 11·51 | 33·93 |
| » 16 | 30′ | 20°00′ | 78 | — |
| » » | 27′ | 19°37′ | 46 | 32·95 |
| » 17 | 21′ | 08′ | 60 | 33·31 |
| » » | 23′5 | 18°29′ | 09 | 49 |
| » » | 27′5 | 17°57′ | 10·61 | 35 |
| » » | 42′ | 34′ | 11·02 | 40 |
| » » | 44′ | 16°58′ | 00 | 66 |
| » » | 51′ | 23′ | 10·62 | 34·25 |
| » » | 64°00′ | 15°52′ | 10·30 | 42 |
| » » | 07′ | 22′ | 8·40 | 33·51 |
| » » | 11′5 | 05′ | 6·82 | 34·00 |
| » » | 16′ | 14°48′ | 47 | 2 |
| » » | 18′ | 38′ | 40 | 02 |
| » 18 | 28′ | 07′ | 5·85 | 47 |
| » » | 36′5 | 13°52′ | 40 | 51 |
| » » | 49′ | 35′ | 3·90 | 22 |
| » » | 65°05′ | 23′ | 4·45 | 33·89 |
| » » | 18′ | 48′ | 6·8 | 32·0 |
| » » | 17′ | 54′ | 85 | 30·65 |
| VIII 30 | 63°41′ | 22°06′ | 12·28 | 34·88 |
| » » | 36′ | 21°23′ | 20 | 83 |
| » » | 31′ | 20°33′ | 11·67 | 79 |
| » 31 | 25′ | 03′ | 70 | 49 |
| IX 1 | 02′ | 19°50′ | 12·28 | 35·16 |
| » » | 62°54′ | 11′ | 29 | 14 |
| » » | 46′ | 18°31′ | 00 | 14 |
| » 2 | 37′ | 17°52′ | 11·62 | 16 |
| » » | 29′ | 11′ | 12·65 | 19 |
| » » | 21′ | 16°31′ | 60 | 18 |
| » » | 12′ | 15°51′ | 70 | 21 |
| » » | 03′ | 12′ | 30 | 21 |
| » » | 61°49′ | 14°11′ | 08 | 23 |
| » » | 42′ | 13°31′ | 17 | 25 |
| » » | 33′ | 12°52′ | 11·75 | 25 |
| » 3 | 24′ | 15′ | 12·35 | 25 |
| » » | 15′ | 11°35′ | 47 | 25 |
| » » | 08′ | 10°57′ | 20 | 26 |
| » » | 00′ | 18′ | 11·70 | 26 |
| » » | 60°40′ | 9°20′ | 10·72 | 24 |
| » » | 35′ | 03′ | 11·25 | — |
| » » | 32′ | 8°44′ | 10·80 | 25 |
| » » | 21′ | 10′ | 80 | 25 |
| » 4 | 10′ | 7°37′ | 11·72 | 29 |
| » » | 59°58′ | 03′ | 12·70 | 28 |
| » » | 47′ | 6°28′ | 80 | 21 |
| » » | 34′ | 5°41′ | 92 | 18 |
| » » | 23′ | 10′ | 90 | 34·90 |
| » » | 11′ | 4°38′ | 90 | 92 |
| » » | 00′ | 02′ | 80 | 87 |

| Time | N Lat. | W Long. | Surf. temp. | Surf. salin. |
|---|---|---|---|---|
| 1905 | | | | |
| V 23 | 64°19′ | 14°39′ | 6·73 | 34·90 |
| » » | 10′ | 15°09′ | 7·23 | 92 |
| » » | 02′ | 40′ | 81 | 35·01 |
| » » | 63°55′ | 16°08′ | 97 | 08 |
| » » | 51′ | 25′ | 51 | 34·81 |
| » 25 | 36′ | 29′ | 66 | 87 |
| » » | 30′ | 26′ | 64 | 35·05 |
| » » | 27′ | 24′ | 50 | 03 |
| » » | 21′ | 22′ | 71 | 14 |
| » 26 | 13′ | 17′ | 75 | 17 |
| » » | 07′ | 12′ | 8·05 | 20 |
| » 27 | 62°55′ | 15°38′ | 15 | 23 |
| » » | 43′ | 04′ | 32 | 23 |
| » » | 30′ | 14°30′ | 16 | 23 |
| » » | 15′ | 13°48′ | 05 | 24 |
| » » | 07′ | 05′ | 15 | 25 |
| » 28 | 61°59′ | 12°22′ | 28 | 26 |
| » » | 50′ | 11°38′ | 62 | 28 |
| » » | 31′ | 19′ | 75 | 28 |
| » » | 11′ | 00′ | 87 | 28 |
| » 29 | 60°43′ | 10°42′ | 61 | 29 |
| » » | 31′ | 26′ | 82 | 30 |
| » » | 17′ | 9°57′ | 9·30 | 30 |
| » » | 04′ | 28′ | 15 | 30 |
| » 30 | 59°49′ | 8°58′ | 19 | 30 |
| » » | 38′ | 25′ | 39 | 35 |
| » » | 27′ | 7°52′ | 78 | 39 |
| » » | 15′ | 23′ | 87 | 41 |
| » » | 06′ | 10′ | 10·02 | 43 |
| » 31 | 58°45′ | 6°26′ | 9·91 | 37 |
| » » | 07′ | 10′ | 8·85 | 34·79 |
| VI 6 | 22′ | 51′ | 10·03 | 35·03 |
| » » | 12′ | 7°25′ | 01 | 30 |
| » » | 02′ | 8°00′ | 9·83 | 25 |
| » » | 57°46′ | 9°01′ | 10·53 | 40 |
| » » | 45′ | 31′ | 80 | 39 |
| » 7 | 45′ | 57′ | 63 | 39 |
| » » | 43′ | 10°34′ | 39 | 34 |
| » » | 47′ | 11°34′ | 53 | 31 |
| » 9 | 27′ | 9°50′ | 11·35 | 40 |
| » » | 02′ | 50′ | 15 | 41 |
| » 10 | 56°56′ | 22′ | 20 | 42 |
| » » | 31′ | 22′ | 21 | 40 |
| » 11 | 00′ | 57′ | 93 | 43 |
| » 12 | 55°32′ | 47′ | 12·09 | 37 |
| » » | 04′ | 58′ | 40 | 37 |
| » » | 54°40′ | 10°07′ | 13·21 | 01 |
| » » | 18′ | 15′ | 12·12 | 34·97 |
| » 13 | 53°54′ | 26′ | 13·38 | 78 |
| » » | 31′ | 35′ | 40 | 81 |

| Time | N Lat. | W Long. | Surf. temp. | Surf. salin. |
|---|---|---|---|---|
| 1905 | | | | |
| VI 13 | 53°06′ | 10°47′ | 13·36 | 35·35 |
| » » | 52°47′ | 56′ | 95 | 48 |
| » » | 27′ | 11°02′ | 14·23 | 49 |
| » » | 06′ | 10′ | 11 | 52 |
| » » | 51°49′ | 32′ | 13·90 | 48 |
| » 14 | 32′ | 12°03′ | 80 | 52 |
| » 15 | 00′ | 11°43′ | 79 | 46 |
| » 16 | 13′ | 10°30′ | 98 | 46 |
| » 18 | 24′ | 8°18′ | 14·25 | 23 |
| » 19 | 03′ | 22′ | 35 | 34 |
| » » | 50°43′ | 26′ | 20 | 44 |
| » » | 19′ | 30′ | 22 | 37 |
| » » | 00′ | 35′ | 21 | 37 |
| » » | 49°39′ | 39′ | 14 | 41 |
| » » | 14′ | 45′ | 05 | 39 |
| » 20 | 48°53′ | 48′ | 13·71 | 56 |
| » » | 33′ | 52′ | 52 | 56 |
| » 21 | 47°53′ | 20′ | 14·18 | 58 |
| » » | 42′ | 7°55′ | 41 | 58 |
| » » | 47′ | 8°00′ | 40 | 53 |
| » 22 | 25′ | 7°06′ | 15·41 | 61 |
| » » | 13′ | 6°12′ | 14·07 | 61 |
| » 23 | 48°05′ | 9°27′ | 15·12 | 57 |
| » » | 19′ | 10°09′ | 07 | 53 |
| » » | 32′ | 48′ | 41 | 64 |
| » 24 | 48′ | 11°28′ | 41 | 53 |
| » » | 49°00′ | 12°00′ | 04 | 48 |
| » » | 25′ | 20′ | 14·61 | 47 |
| » 26 | 53′ | 11°51′ | 15·10 | 52 |
| » » | 57′ | 04′ | 14·16 | 49 |
| » » | 50°02′ | 10°01′ | 15·51 | 52 |
| » » | 02′ | 9°29′ | 16·06 | 52 |
| » » | 02′ | 8°45′ | 25 | 41 |
| » » | 02′ | 7°57′ | 30 | 30 |
| » 27 | 02′ | 05′ | 02 | 26 |
| » » | 02′ | 6°20′ | 14·74 | 26 |
| » » | 49°56′ | 5°22′ | 15·35 | 30 |
| » » | 56′ | 00′ | 14·74 | — |
| » » | 50°15′ | 4°19′ | 15·10 | 21 |
| » 29 | 22′ | 2°12′ | 13·87 | 17 |
| » » | 32′ | 1°05′ | 15·21 | 34·92 |
| » » | 35′ | 0°03′ | 14·30 | 35·01 |
| » 30 | 43′ | 0°43′ E | 13·69 | 19 |
| » » | 51°13′ | 1°36′ E | 14·95 | 34·74 |
| VIII 27 | 65°16′ | 13°29′ | 7·51 | 33·80 |
| » » | 05′ | 24′ | 30 | 96 |
| » » | 64°56′ | 25′ | 47 | 34·04 |
| » » | 44′ | 40′ | 6·82 | 22 |
| » » | 33′ | 50′ | 7·80 | 20 |
| » » | 23′ | 40′ | 46 | 22 |

| Time | N Lat. | W Long. | Surf. temp. | Surf. salin. |
|---|---|---|---|---|
| 1905 | | | | |
| VIII 27 | 64°12′ | 13°31′ | 9·44 | 34·78 |
| » » | 02′ | 21′ | 7·85 | 34 |
| » » | 63°52′ | 11′ | 11·24 | 35·08 |
| » » | 42′ | 02′ | 02 | 08 |
| » 28 | 32′ | 12°55′ | 10·71 | 10 |
| » » | 24′ | 46′ | 62 | 10 |
| » » | 14′ | 37′ | 68 | 10 |
| » » | 05′ | 29′ | 51 | 14 |
| » » | 62°55′ | 20′ | 85 | 16 |
| » » | 45′ | 13′ | 11·15 | 18 |
| » » | 36′ | 05′ | 22 | 16 |
| » » | 26′ | 11°57′ | 60 | 17 |
| » » | 17′ | 48′ | 58 | — |
| » » | 08′ | 40′ | 62 | 16 |

| Time | N Lat. | W Long. | Surf. temp. | Surf. salin. |
|---|---|---|---|---|
| 1905 | | | | |
| VIII 28 | 61°58′ | 11°31′ | 11·80 | 35·16 |
| » » | 49′ | 23′ | 80 | 12 |
| » » | 39′ | 16′ | 80 | 16 |
| » 29 | 30′ | 08′ | 87 | 16 |
| » » | 20′ | 00′ | 61 | 16 |
| » » | 05′ | 10°55′ | 12·04 | 16 |
| » » | 60°48′ | 50′ | 11·44 | 22 |
| » » | 32′ | 45′ | 05 | 21 |
| » » | 15′ | 40′ | 42 | 17 |
| » » | 00′ | 35′ | 12·44 | 21 |
| » 30 | 59°43′ | 32′ | 32 | 21 |
| » » | 27′ | 25′ | 74 | 28 |
| » » | 10′ | 20′ | 13·05 | 30 |
| » » | 58°53′ | 15′ | 40 | 29 |

| Time | N Lat. | W Long. | Surf. temp. | Surf. salin. |
|---|---|---|---|---|
| 1905 | | | | |
| VIII 30 | 58°36′ | 10°10′ | 13·18 | 35·32 |
| » » | 19′ | 06′ | 15 | 30 |
| » » | 02′ | 01′ | 41 | 31 |
| » 31 | 57°46′ | 9°55′ | 50 | 30 |
| IX 1 | 56′ | 18′ | 40 | 30 |
| » » | 58°06′ | 8°46′ | 34 | 30 |
| » » | 15′ | 14′ | 15 | 28 |
| » » | 25′ | 7°40′ | 05 | 25 |
| » 2 | 30′ | 00′ | 12·91 | 28 |
| » » | 42′ | 6°13′ | 13·03 | 14 |
| » » | 43′ | 5°31′ | 12·90 | 34·96 |
| » » | 43′ | 4°48′ | 62 | 85 |
| » » | 43′ | 09′ | 62 | 88 |
| » » | 43′ | 3°30′ | 40 | 35·03 |

# Discussion of the Sections.

The observations here published constitute together with a few former reports[1]) what has been done on the three summer expeditions to Iceland with the Danish research-steamer "Thor" in 1903—1905 in the way of hydrographical measurements in the deep basin of the Atlantic Ocean that is bounded on the north by Iceland and the submarine ridge between Iceland and the Faroe Islands. Since the regular quarterly hydrographical measurements, according to the program of the Stockholm and Christiania Conference, are taken across the above mentioned ridge, of course the observations treated here are of a more scanty and casual nature; for they have been taken partly in connection with fisheries investigations proceeding from the coast out toward deeper water for the purpose of noting the propagation of fish and fry, partly on the voyages to and from Iceland. Here too we must emphasize the rough weather which is so prevalent in these waters and which has been a great drawback for the investigations of former expeditions (for instance the Danish "Ingolf" Expedition and the English "Lightning" Expedition), and "Thor" had several times the same experience on the way to and from Iceland, the weather often being so bad that the investigations either could not be carried on to so great an extent as desired or had to be given up entirely.

The most important results of the "Ingolf" Expedition's[2]) investigations south of Iceland were the great homogeneousness of distribution both of temperature and salinity and the fact that both isotherms and isohalines rise nearer to the surface over toward the south coast of Iceland. These results have been in the main confirmed by our investigations even if so far as the temperature is concerned there seem to be rather important variations, for the new methods of measuring the temperature give much more exact results than those formerly obtained by means of Negretti & Zambra's reversing thermometer.

Since our comparatively few observations have the disadvantage of having been made at long intervals, indeed that they even extend over a period of three years, they cannot give us any answer to the important question as to the direction of movement of the water south of Iceland. We know that the enormous masses of warm water that flow between the British Islands and Greenland toward the north or northeast divide in such a way that a part — probably the greater part — flows between Scotland and the Faroe Islands into the North Sea and the Norwegian Sea (yet a considerable part flows into the Norwegian Sea north of the Faroe Islands) while another part flows into the Denmark Strait west of Iceland. The question is now where this division takes place. Since there is probably no essential difference in physical and chemical properties between the two branches, we should need, in order to solve this problem, a great number of careful observations in sections out from the coast of Iceland at as short intervals of time as possible, and as already remarked, the observations here under consideration are far from adequate in this respect, but yet we can say here that in all probability this division takes place off the south coast of Iceland. The fact that the cross-section of the Atlantic masses of water which through the northern part of the Denmark Strait get over the submarine ridge between Iceland and Greenland and pass on to the north coast of Iceland is very small in comparison with the masses of water considered here seems undeniably to indicate that the division in question must take place far over toward the west, and we have already in connection with the report of the observations from 1903 said that the theory according to which the division may be found even east of Iceland on 10° — 12° W. Long.[3]) cannot very well be brought in harmony with the actual conditions; besides we have

[1]) Meddelelser fra Kommissionen for Havundersøgelser. Serie: Hydrografi, Bind I, No. 4, Køb. 1904.

[2]) Den danske "Ingolf" Expedition. Martin Knudsen: Hydrografi. Køb. 1898.

[3]) C. Ryder: Some Investigations Relating to the Ocean Currents in the Sea between Norway, Scotland and Greenland. Naut.-Met. Ann. of the Danish Met. Inst. 1901.

from the last two years several observations which indicate that the division takes place much farther toward the west. This matter, however, we shall come back to later.

Of the Sections I—V, we shall now call attention to the conditions that are typical for the waters south of Iceland (the deep basin with depths of about 2000 meters). What is most characteristic for these waters is the great layer of water with a high temperature which vertically varies exceedingly little; for instance if we consider the conditions in the spring (the month of May), then the temperature at the surface is generally a little under 8° C. and gradually decreases to 7° at a depth of about 800 meters. From this depth the temperature decreases more rapidly; it is for instance about 5° at a depth of 1000—1100 meters, and after it has sunk to 4° C. at a depth of 1300—1400 meters, it again decreases very slowly to 3° or a little under 3° at depths of 2000 meters. The salinity varies in exact accordance with the temperature so that the salinity is about 35·25 ‰ in the layer of water whose temperature is over 7°, whereupon it sinks and gets a value of about 35·10 ‰ when the temperature is 5°, and has finally a value of about 35·00 ‰ when the temperature has sunk to 3° C.

In the summer the uppermost layer of water is warmed up by the sun and the atmosphere and there is generally a pretty sharp limit to this heated surface layer; toward the end of the summer (in the latter part of August and the beginning of September), the surface temperature has risen to about 12°, and the limit mentioned is found at a depth of about 75 meters. When fall comes, this thin warm surface layer cools comparatively quickly on account of the transmission of heat to the atmosphere, and then we generally find a somewhat lower temperature at the very surface than a little under it, yet only a few hunderths [1]) of a degree as long as the salinity in the surface is not lower than it is a little deeper down; in the latter case the difference of temperature may prove to be greater. These are the typical conditions in winter, and they indicate that convection, i. e. vertical, currents must arise as a result of the cooling of the upper layers of water which then become heavier than the lower layers and therefore sink down and partly mix with the latter. When the warmer layer nearest the surface has cooled off in this way to the same temperature as that found below the surface layer which is warmed up in the summer (about 75 meters), and when the surface then continues to cool off, the result will be that these convection-currents will reach down to much greater depths, and when, as in this case, the salinity is about constant in a vertical direction, then the temperature too in that layer of water which has been subjected to the influence of the convection-currents will remain about constant, and vice versa we can generally infer from such a constant temperature and salinity that the layer of water in question has been subjected to convection.

In these convection-currents we no doubt have the cause of the special conditions of temperature that are found in the uppermost layer of water (about 800 meters thick). In the winter the temperature of the air in this region is considerably lower than the temperature of the water. For instance the temperature of the air at the Westmanna Islands a little south of Iceland is only a little over 0° C. in the winter (mean value for the year 5·1 [2])), while the surface temperature over great depths probably does not sink below 7° C. Consequently there will arise a lively interchange of heat between the water and the atmosphere and through the cooling of the surface water thus brought about there will arise convection currents in the ocean, which, to judge by the distribution of temperature, will reach down to a depth of about 800 meters, and it is highly probable that a series of measurements of temperature taken during the coldest season of the year, or rather a little later (March or April) would give constant temperature throughout a high layer of water. That the temperature does not continue to remain constant but, as observations made in the course of the summer show, decreases slowly downward, is of course

[1]) Contribution to the Hydrography of the Waters North of Iceland. Medd. fra Komm. for Havundersøgelser. Serie: Hydrografi. Bind I, No. 7, p. 12, Køb. 1905.

[2]) Meteorologiske Middeltal og Extremer for Færøerne, Island og Grønland. App. til Met. Aarb. 1895, II, Køb. 1899.

due to the fact that a part of these masses of water goes farther north to the Norwegian Sea and the Denmark Strait and is replaced by other masses of water with a higher temperature, and since it is to be supposed that the speed of the current is greatest at the surface and decreases with the depth, this afflux will cause exactly such a difference of temperature, the replacing masses of water coming from more southern latitudes where the temperature has been higher in the winter. That the speed of the current decreases with the depth there is scarcely any reason to doubt, but it is in this case perfectly obvious, since the submarine ridges under a certain depth (for instance the Faroe-Iceland Ridge for depths greater than 500 meters) stop the movement of the water and only allow it to rotate in the basin itself.

If this hypothesis were in agreement with the actual conditions we should expect the decrease of the temperature with the depth to be slower in the beginning than toward the end of the summer. In the following Table 1 is given the fall in temperature pr. 100 meters at different depths for Stations taken in May, July and the end of August, and in Table 2 is given the means for the fall in temperature for the Stations taken in the end of May, in the middle of July, and in the end of August.

Table 1.

| | St. 40 $^{24}/_{5}$ 04 | St. 39 $^{23}/_{5}$ 04 | St. 50 $^{28}/_{5}$ 05 | St. 26 $^{31}/_{5}$ 03 | St. 51 $^{13}/_{7}$ 03 | St. 52 $^{14}/_{7}$ 03 | St. 65 $^{11}/_{7}$ 04 | St. 122 $^{29}/_{8}$ 05 | St. 121 $^{28}/_{8}$ 05 | St. 120 $^{27}/_{8}$ 05 |
|---|---|---|---|---|---|---|---|---|---|---|
| 0—50 | 0·01 | 0·09 | 0·15 | 0·18 | 1·42 | 2·67 | 2·44 | 1·45 | 1·92 | 1·61 |
| 50—100 | ·08 | ·09 | ·14 | ·17 | 0·73 | 0·43 | 0·45 | 1·47 | 1·10 | 1·19 |
| 100—200 | ·10 | ·13 | ·33 | ·08 | ·37 | ·31 | ·38 | 0·44 | 0·39 | 0·42 |
| 200—300 | ·05 | ·03 | ·105 | ·10 | ·09 | ·10 | ·115 | ·135 | ·12 | ·08 |
| 300—400 | | | | ·07 | ·14 | ·14 | | | | |
| 400—500 | ·032 | ·167 | ·155 | ·11 | ·12 | ·20 | ·17 | ·10 | ·18 | ·17 |
| 500—600 | | | | ·147 | ·15 | | | | [·80] | |
| 600—700 | | | ·195 | ·20 | [·40] | [·50] | | ·165 | | |
| 700—800 | | | | | | | | | | |

Table 2.

| | May (End) | July (Middle) | August (End) |
|---|---|---|---|
| 0—50 | 0·11 | 2·18 | 1·66 |
| 50—100 | ·12 | 0·54 | 1·25 |
| 100—200 | ·16 | ·35 | 0·42 |
| 200—300 | ·07 | ·10 | ·11 |
| 300—400 | ·06 | ·135 | ·11 |
| 400—500 | ·09 | ·16 | ·15 |
| 500—600 | ·12 | ·17 | [·10] [1] |
| 600—700 | ·15 | [·36] | [·17] |
| 700—800 | ·15 | [·36] | [·17] |

From Table 2, it will be seen that the difference of temperature really increases in the course of the summer even at such depths to which no transmission of warmth could possibly take place from the surface, and so the only plausible explanation of these conditions is that they are caused by the afflux of new and somewhat warmer masses of water which have moved with a speed that is greatest at the surface and decreases with the depth. Since the first group of temperature-measurements in Table 2 were taken as much as 3 months later than the coldest season of the year we of course cannot expect the

[1]) Only 1 series of observations.

constant temperature produced by the vertical currents because as soon as the convection ceases this constant temperature must disappear on account of the steady afflux of the warmer masses of water coming from more southern latitudes where the temperature of the water is higher. All this that has been said here makes it seem probable that the uniform temperature in the uppermost layer of water (about 800 meters thick) is due to the fact that in the winter this layer under the influence of convection-currents gets a constant temperature in a vertical direction, and that the convection is felt down to a depth of about 800 meters.

What has here been said about the distribution of temperature is applicable only when the depth of the water is 1500 meters or more. Both "Ingolf"s observations and those mentioned of here show in general that the course of the isotherms partly conforms to the form of the bottom; thus we see in Section IV that the 7° isotherm at St. 64 even lies 150 meters from the bottom although the depth is only about 650 meters. At a first glance it seems strange that the colder and heavier underlayer shoots up over the slopes toward the greater depths since the condition for the maintenance of equilibrium is that the isopyknics are horizontal; of course we must remember here that the difference in specific gravity is not as great as the difference in temperature would lead us to suppose, because lower temperature is as a rule accompanied by lower salinity, still so that in general the specific gravity increases with decrease of temperature.

However it is a question if the convection is not causally connected with the tendency of the isotherms to go parallel with the bottom. Let us assume that in the basin here under consideration there is a rather extensive shallow with a depth of for instance 100 meters. Gradually as the surface cools off, the surface water sinks down, mixing with the masses of water below and is partly replaced by them; when this effect is felt to a depth of 100 meters — thus to the bottom in the case of the shallow — the masses of water over the shallow will cool off more rapidly than deeper water and will thus become heavier than the surrounding water at the same depth; they will consequently sink and then move down the slopes toward the surrounding greater depths while their place over the shallow will be filled by the surrounding masses of water, which will in turn cool off more rapidly etc. etc. Then the result will be that the water over such a shallow will become colder than the surrounding water, and how low a temperature will be reached depends of course upon the extent of the shallow; this colder water sinks down the slopes toward the greater depths until it reaches a depth where the specific gravity of the water already there is the same as that of the water that has been cooled off over the shallow (here of course we have not taken into consideration any mixing and warming that might take place on the way).

Now all around Iceland there are such shallows of greater or less extent, and on "Thor"s expedition in April 1904 it was proved that the temperature of the water nearest the coast was in reality considerably lower than that of the surrounding sea, a circumstance that no doubt may partly be due to the fact that the temperature of the air over Iceland in the winter is lower than over the sea, so that the cooling process on that account will take place more rapidly nearest land; but on the other hand we also have a thinner layer of water here which can cool off from the surface to the bottom comparatively quickly and thus get a specific gravity higher than that of the surrounding waters at the same level outside of the coast shallow, and the coast water will consequently move out toward greater depths thus causing in the coldest season of the year a surface current flowing toward land and a bottom current flowing in the opposite direction. Where the coast shallow slopes gradually toward the deep basin this movement will be slower than where the shallow ends precipitously, and when in addition to this the water in the vicinity of the coast has become thinned by an admixture of fresh water, this will diminish the difference in specific gravity and thereby further diminish the speed of this movement. Thus it is not improbable that the colder water which, as mentioned above, is found at the bottom at Station 64

(1904) has originated in exactly this way and has a downward movement along the bottom, and that this circumstance is the reason why the isotherms toward the coast-shallows partly conform to the form of the bottom.

In the eastern part of the basin in question near the Faroe-Iceland Ridge, this tendency of the isotherms to go parallel with the bottom is still more pronounced than in the western part (v. e. g. Sect. VI), and here we find bottom-temperatures that are considerably lower than farther west. Thus the temperature at the bottom at St. 121 at a depth of only 700 meters is 1°75 and since so low a temperature has not been observed even at the greatest depths farther west, it cannot be explained by the supposition that the bottom-water from the western part of the basin from some inexplicable cause might have shot up over the shallows in the eastern part of the basin. However we have already before[1]) shown that when the colder masses of water from the East-Icelandic polar current at a point north of the Faroe-Iceland Ridge meet the warm Atlantic masses of water, which as a surface current make their way over the ridge then the colder water shoots in under the warmer, and as an undercurrent makes its way toward the south over the ridge, and when the cold masses of water by flowing under the warm current have become somewhat warmed up and through a partial mixture with the warm water have got a higher salinity (about 35·00 ‰), these masses of water, which are now physically changed, move down the southern slope of the ridge and form the bottom-water in the northern basin of the Atlantic Ocean, and the cause of the lower temperature of the bottom-water in the eastern part of this basin is accordingly to be found in the masses of water of Arctic origin that shoot down over the submarine ridge between the Faroe Islands and Iceland.

From the Sections taken in May and August 1903[1]) across the Faroe-Iceland Ridge, it is obvious that the bottom temperature is lower over the western than over the eastern part of the ridge and accordingly that this cold undercurrent is more pronounced nearest Iceland. It agrees very well with this when at St. 38, May 1904, there is no such cold bottom water at all, the temperature at the bottom (640 meters) being 7°72. The reason why this undercurrent is most pronounced toward the west is probably to be found in the fact that the masses of water of the East-Icelandic polar current nearest Iceland move in a southerly direction while the direction of movement over toward the Faroe Islands is changed to easterly, accordingly parallel with the ridge, and these eastbound masses of water will of course not have as great a chance of slipping over the ridge as the southbound water along the east coast of Iceland since the latter move about at right angles to the ridge.

We have here treated the basin from the Faroe Bank in the east to the Reykjanæs Ridge in the west as one, since the conditions here, as is evident from Section IV, are very uniform especially with respect to the vertical variation in temperature and salinity, only it must be remarked that both the temperature and the salinity are a little higher in the eastern than in the western part. However the difference is not great; in salinity it is scarcely ever more than 0·05 ‰, and as for the temperature it is about 0°5 at the surface and this difference generally decreases with the depth; thus we see that the 7° isotherm in Section IV goes about horizontally west of the Faroe Bank until over toward the shallow south of Reykjanæs it rises somewhat.

We may now ask if there is any periodicity in the variation of the temperature and the salinity. This question can of course not be adequately answered by these observations which have been made only during the summer, but so far as the surface water is concerned, copious material has been collected from ships sailing to Iceland and Greenland. From Martin Knudsen's summary of

[1]) Medd. etc. No. 4, 1904.

this material[1]), it appears that the salinity of the surface water is least in September-October and greatest in April-May, while, as seems obvious enough beforehand, the maximum of temperature falls in August and the minimum in March. Thus the maximum and minimum of salinity does not come until 1 to 2 months after the minimum and maximum of temperature; it must however be remarked that the salinity is on the whole low in August—October. We have previously said that the high surface temperature in the summer is due to the warmth from the sun and the atmosphere, a fact that is plain enough from the tables on page 11, the layer at the surface where the higher temperature is found being quite thin; in the middle of July it is less than 50 meters thick, and in the end of August the thickness is still less than 100 meters, and the transition from the higher to the lower temperature is in both cases rather sharp.

However from what has previously been said about convection-currents in the uppermost (about 800 meters thick) layer of water it is evident that the temperature here must have a yearly period, being presumably lowest at the time when the convection ceases — probably in March-April — whereupon it rises in the course of the summer, and has presumably reached its highest value in the fall before the convection again begins to make itself felt. How great this difference in temperature is we cannot decide, since we have no observations from the time when the temperature is lowest, and since moreover the temperature-series that are taken in the latter part of August are probably somewhat lower than the maximum values, yet we can get an idea of this difference by a comparison of the two stations 50 ($^{28}/_{5}$ 1905) and 122 ($^{29}/_{8}$ 1905) which are taken at about the same point northwest of the Faroe Bank.

| Depth (Meters) | | 0 | 25 | 50 | 75 | 100 | 200 | 400 | 600 | 800 | 1000 | 1100 | 1200 | 1300 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Temp. | St. 122 | 11·61 | 11·45 | 10·16 | 9·28 | 8·67 | 8·23 | 7·96 | 7·76 | 7·43 | 6·90 | 5·73 | 3·92 | 3·65 |
| | St. 52 | 8·62 | 8·54 | 8·47 | 8·40 | 8·33 | 8·00 | 7·79 | 7·48 | 7·09 | 6·21 (950) | 3·07 | | |
| Difference | | 2·99 | 2·91 | 2·69 | 0·88 | 0·34 | 0·23 | 0·17 | 0·28 | 0·34 | [0·69] | [2·66] | | |

From this table we see that at the depths from 100 to 800 meters, the temperature has in the course of those 3 months risen on an average 0°27 and therefore it is probable that the amplitude for the yearly variation of temperature for this interval is about 0°5 C., and consequently a measurement of the temperature made at a depth of a couple of hundred meters or more could not here be regarded as a mean value for the year; this rule made by A. Buchan[2]) can only be applied approximately and must at any rate only be applied to places where the winter temperature of the atmosphere is not so low that the cooling of the surface causes convection down to a greater depth than that reached by the warming in the summer. Of course we must always remember that the warm masses of water are in the closest proximity to polar currents and that their temperature is much higher than the normal temperature for that latitude, which causes quite extraordinary conditions in the exchange of warmth that takes place between the atmosphere and the sea-surface.

If we now consider the salinity it is obvious that in the winter when convection prevails it must remain constant in that layer of water where the convection-currents are found. This constant value gives exactly the maximum of surface salinity, this being found, according to Martin Knudsen, in the end of April. We have taken for granted that the convection-currents create constant salinity in that layer of

[1]) Martin Knudsen: Contribution to the Hydrography of the North Atlantic Ocean. Medd. fra Komm. for Havunders. Serie: Hydrografi. B. I, No. 6, Køb. 1905.

[2]) A. Buchan: Report on Oceanic Circulation. Report on the Scientific Results of the Voyage of H. M. S. "Challenger" 1872—76. Summary of Results.

water in which they are found, a fact of which in reality there can be no doubt, but it must be said here that the distribution of salinity may be such that convection-currents do not arise. For if the salinity in the surface-water is so low that its specific gravity, even when it is cooled down to its freezing point, continues to be less than the specific gravity of the salter water below, then this surface layer may cool off — indeed even freeze — and still the convection-currents will not get down to the salt underlayer and the latter will thus be prevented through the protection of the fresh surface layer from cooling off in any other way than by transmission of warmth to the cold layer above it. In order to get an idea of the figures in the case, let us assume that the underlayer has a temperature of 7° C. and a salinity of 35·25 ‰; then its specific gravity (under a pressure of 1 atmosphere) will be 1·02764 or with the shorter designation $\sigma_t = 27{\cdot}64$. Then the temperature of the surface layer can sink to 0° C. without causing convection when its salinity is lower than 34·40 ‰, the specific gravity of water with this salinity being 27·64 at 0° C. But if the salinity in the surface layer is over 34·40 ‰, then before it reaches the temperature 0° (e. g. at a temperature of 6° if the salinity is 35·08 ‰), it will become heavier than the underlayer and consequently sink down and mix with the warmer and salter masses of water; thus as the surface continues to cool off the difference both in temperature and salinity will gradually be eliminated, and since the salinity in the surface rarely is under 35·00 ‰ it is obvious that such a surface-layer will not protect the under layer against the powerful mixing process arising from the convection-currents.

We have already mentioned the fact that Martin Knudsen in discussing the surface observations collected from the mail-steamers has come to the result that the salinity of the surface water is greatest in early spring (April) and least toward the end of summer (September—October). The salinity determinations spoken of here seem to indicate that the salinity in the whole of the warmer layer (down to the depth of 800 meters) is a few hundreths of a promille lower in the latter part of the summer than in the spring, but the difference is so little that there may be some doubt if there is any at all. On the other hand it has been repeatedly shown — especially late in the summer — that the salinity increases from the surface down; this is for instance the case at Stations 120—123 (August 1905), Section VI where the salinity in the surface is respectively 35·08 ‰, 35·16 ‰, 35·16 ‰, 35·21 ‰ and increases downward until it reaches its normal value at a depth of about 100 meters. Since the salinity in the surface thus may be somewhat lower than that in the thick layer of warm water it would of course be in the very highest degree hazardous on the basis of the salinity of the surface water to draw conclusions — as has sometimes been tried — with regard to this Atlantic current's power and extent and variation, if there is any, with the seasons; such information could be obtained only by means of a systematic investigation of the extent in breadth and depth of the warm masses of water and by direct or indirect determinations of the speed of the current.

Now what is the cause of this low salinity in the surface layer? On the route between the Faroe Islands and Iceland two explanations suggest themselves; the first one is that the fresh surface water from the East-Icelandic polar current having become warmed up during the summer and having consequently become lighter than the surrounding masses of water may flow out over the latter: the second and rather more probable explanation is that the fresh water comes from the south and east coast of Iceland and from there flows in an eastern direction toward the Faroe Islands. But even as far south as on the Greenland route — 60° N. Lat. — we find similar conditions; thus we see that the isohalines in the course of the summer shift toward the east and this circumstance may give us a hint in the right direction. For west of this Atlantic current we have colder and fresher masses of water all the way north from the coast of North America; in the summer when the surface of this water is warmed up by the sun's rays and the warm atmosphere, a thin layer of this fresher water will become strongly warmed up, its specific gravity will become less than that of the salter water toward the east and it will therefore flow out over the latter as a thin surface layer and gradually mix with it. Besides the icebergs which are borne

down by the polar currents toward the warmer water will often find their way in the latter (for instance at New Foundland) and melt there, and this ice-water which is practically without salt will likewise do much toward reducing the salinity in the surface.

We shall now try to find out if the ice-water that flows out over the warm current at New Foundland can reach Iceland in the fall. Let us assume that the convection in the waters around New Foundland has so far ceased in the middle of April that such a fresher upper layer can exist without mixing with the salter water below. Since the drift-ice limit off the coast of New Foundland, according to the English Admirality charts, in the spring is generally at 38°—40° W. Long. and 40°—44° N. Lat., and since the distance between this point and Iceland is about 1300 miles, this fresher water can reach Iceland by the middle of October if it moves at an average speed of about 7 miles a day — a rate of speed that is even less than that which is given for this expanse of water on the above-mentioned charts (10 miles a day), and thus it seems probable that the lower value of the salinity in the surface layer of the area under discussion in the end of summer is owing to the fresher masses of water from the East-Greenlandic polar current and the Labrador current.

In the winter the polar water has not as great a tendency to move in this way on account of the lower temperature which gives high specific gravity and also in part because the convection currents mix it with the under layer. Thus since the salinity in the surface layer south of Iceland is in the fall generally only 0·1—0·2 ‰ under the normal, a cooling of the surface water of about 1° will produce convection, whereby the difference in salinity is gradually eliminated, and when this has happened, the maximum of salinity takes place in the surface water and this maximum value may consequently be considered the salinity for all that layer of water which has taken part in this vertical movement.

As to the bottom layer in the basin, our observations in this are too few to enable us to enter upon a discussion of the conditions there; we can however remark that the underlayer cannot be a result of cooling at the place itself since the temperature there never becomes so low at the surface; so it must have been conveyed from some other place, and we have then the cold water that flows over the Faroe-Iceland Ridge, and similar conditions are probably to be found to a far greater extent between Iceland and Greenland. The East-Greenlandic polar current is in the Denmark Strait, to be sure, only a surface current, since the cold water only reaches a depth of a couple of hundred meters, under which there are warm masses of water with about the same characteristics as in the rest of the Denmark Strait; but there is scarcely any doubt that the cold water in the northern part of the strait, especially over the western part of the ridge between Iceland and Greenland, reaches down to the bottom or what is equally significant in this connection rests on an under layer with the same characteristics as the bottom water of the North Ocean, i. e. temperature under 0° C., salinity 34·90 ‰ or a little over. The uppermost layer, which is ice-bearing and very little salt, continues its movement as a surface current while the lower layer shoots down in Denmark Strait as bottom water. We have a number of observations that show this, for instance the measurements from "Fylla", Capt. Jacobsen[1]) (1877), of which especially one Station at 66° 25′ N. Lat. 25° 50′ W. Long. is typical; nearest the surface is a cold layer of water (temperature even under — 1°); under that a rather thick layer with temperature over 6°; and at a depth of 565 meters the temperature is negative again and sinks to — 1°1 at a depth of 650 meters; at one of "Thor"s Stations in the Denmark Strait (St. 59, 1904)[2]) we have found a bottom temperature of about 0° at a depth of 750 meters.

The East-Greenlandic polar current itself, since it rests on an under layer of warm water, will not take part in the renewing of the bottom water; on the boundary between the warm and the cold

[1]) Capt. N. Hoffmeyer: Geogr. Tidsskrift I, 1878, p. 1 ff. Ann. der Hydrographie 1880, 173—192.
[2]) Medd. fra Komm. for Havunders. Hydrografi No. 7.

water, of course there will be formed masses of water with the same characteristics as the bottom water, but on account of the downward movement of these masses of water, they will mix with the warmer water below and thus will not reach the bottom. But where we have a current of cold water that reaches the bottom, like for instance the Labrador current, it will shoot its colder and heavier masses of water in under the warmer waters in the Atlantic Ocean, where they will gradually mix to a certain extent, and such a current will certainly play a greater part in the renewing of the bottom water of the Atlantic Ocean than the other cold currents from the Arctic Sea, which in contrast to the Antarctic Sea is divided from the Atlantic Ocean by submarine ridges.

The deep basin south of Iceland with depths of over 2000 meters is separated by a more shallow part from the deep channel west of Scotland, the so-called Rockall Channel. At about 14° W. Long. 58° N. Lat. the rock Rockall rises above the surface and this is surrounded by an extensive shallow which is used as fishing-grounds by English and Faroe fishermen. The greatest dimensions of the shallow extend north-south; toward the south it is separated by depths of over 2000 meters from the shallow that extends from Ireland toward the west to the Porcupine Bank; toward the north it is separated by a channel with depths of 1000—2000 meters from the Faroe Bank at about 61° N. Lat. 8°—9° W. Long. In 1905, both English and Faroe fishermen related about a new fishing-bank west of the Faroe Bank, and some soundings taken from "Thor" in May 1905 at about $60^3/_4$° N. Lat. $10^3/_4$° W. Long. (St. 51) actually gave depths less than 200 meters; this new bank whose greatest dimensions extend in an east-west direction is separated from the previously known Faroe Bank by a deeper channel whose depth is probably about 600 meters. The discovery of this new bank shows that the channel between Rockall and the Faroe Bank is narrower than has been supposed, and since we have but few soundings from these waters, it is not improbable that the two shallows really are connected by a ridge with much lesser depths than the charts would lead us to suppose.

We shall now consider the two Sections V and VI, of which the first was taken in May 1905 and extends from north of the Faroe Banks to Scotland, the second in the end of August from Iceland over the Faroe Bank to about 58° N. Lat. In Section V, the part north of the bank shows the characteristic cold bottom water and the consequent close isotherms, while these conditions are not found south of the bank where the bottom temperature at greater depths is over 3°5 higher; of course this is quite natural since the bank prevents the cold bottom water from spreading toward the south and forces it to move in a western direction down into the deep basin south of Iceland. Thus the 7° isotherm lies considerably lower on the south side of the bank than on the north side, but also in the upper layers of water there seems to be an essential difference, since both the 8°5 isotherm, which north of the bank lies quite near the surface, and the 8° isotherm, which is found at a depth of 200 meters, fall with a strong curve to depths of respectively 500 and 800 meters on the south side of the bank; the difference in temperature between the two Stations 50 and 52 lying on opposite sides of the bank is at depths from 200 to 800 meters on an average over 0°5 C.; the salinity too varies somewhat, being higher on the south side of the bank, and especially at St. 53 we find high salinity, over 35·40 ‰. This difference in conditions on opposite sides of the bank seems to indicate that there has been no connection between these masses of water through the channel between Rockall and the Faroe Banks; at all events it precludes the possibility that the masses of water which are found south of the bank have come from the west through this channel, since in that case we should expect to find the temperature about the same as north of the bank.

Section VI, which was taken during the last days of August, of course shows the high temperature in a thin layer at the surface that corresponds to summer conditions; but at a depth of 100 meters, the temperature may be considered normal, i. e. independent of the warming that proceeds from the surface. As mentioned on p. 14, however, the masses of water found here now are different from those

that were found in May, the temperature now being somewhat higher than it was then; remarkable is the great uniformity of temperature at the two Stations (120 and 121) nearest the Faroe-Iceland Ridge, while the temperature rises somewhat in the vicinity of the Faroe Bank, and just as in the preceding Section we see that the isotherms here lie very close to the bottom and that the bottom temperature is very low in relation to the depth, at St. 121 even under 2° C. Further we notice the low salinity in the warm surface layer; nearest Iceland in the coast water at St. 119 the salinity in the surface is only a little over 34‰ but rapidly increases out from the coast and is 35·08 ‰ at St. 120; after that it remains 35·16 ‰ to the Faroe Bank, but we see that already at a depth of 100 meters the salinity has its normal value 35·25 ‰. From this we conclude that this low salinity is not really characteristic of the warm Atlantic current, but, as has previously been remarked, must be due to the polar currents on the west side. Besides the formerly mentioned cause of this diffusion of the fresher water, it is probable that the west and westsouthwest winds that prevail over the northern part of the Atlantic Ocean[1]) play a part.

South of the Faroe Bank, the surface salinity is greater — yet at St. 123 it is still only 35·21 ‰ — but under this there is a salinity of over 35·30 ‰, thus somewhat higher than north of the bank, these conditions being analogous with those found in May, and now too we find in the eastern part of these waters a salinity of over 35·40 ‰. Further we find the same peculiar distribution of temperature as in May, the isotherms south of the bank lying much deeper than the corresponding ones north of the bank, so much so that if there were no bank it would be impossible for the lines to take an uninterrupted course. The only probable explanation of the sudden change in temperature and salinity that is found on crossing over this bank must be that the masses of water found north of the bank have come from the south by passing west of the Rockall Bank and those found south of the Faroe Bank have passed through the Rockall Channel east of the Rockall Shallow. Then the difference in temperature may be explained partly by the fact that the northernmost masses of water have gone a longer distance than the southern ones; they have therefore left the common starting-point before the latter and have consequently the lower temperature; then there is partly the probability that the masses of water that pass west of Rockall may have had a lower temperature from the beginning than those that pass east of the shallow (cf. below p. 22). As yet objections may of course be raised against the above hypothesis; but we hope through future investigations to collect more copious material from this interesting field.

The temperature in the surface increases from north to south, but this increase is not even; it is about 0·6 from St. 120 to St. 122, but it is 0·8 from St. 122 to St. 123 and from there about 1·0 to St. 124, so thus we see that also with respect to the temperature of the surface there is an obvious difference between the two sides of the Faroe Bank. The distribution of temperature is also very interesting at St. 123, the temperature having a minimum at a depth of 100 meters, from where it increases with 0·26 to 150 meters; if we bear in mind that the salinity is 35·21—35·23 ‰ from 0 to 100 meters, while at a depth of 200 meters it is 35·33 ‰, we see that a layer of water over 100 meters thick has been conveyed hither from some other place, for the minimal temperature shows clearly, that these conditions can not have existed for a long time, and besides we know that normally the temperature in the water of the Atlantic Ocean decreases with the depth. The lower temperature and salinity indicate that this surface layer has come from the west north of Rockall from the somewhat mixed surface layer in the North Atlantic Ocean. Moreover this is quite probable since we know that the surface current takes a more easterly direction as soon as Great Britain no longer hinders it, and the surface current probably passes over the whole of the northern part of the warm Atlantic water about in an eastern direction (as is

[1]) Cf. G. Carstens: Untersuchungen über die Strömungen des Atlantischen Ozeans. Wiss. Meeresuntersuch. etc. Abt. Kiel. Neue Folge. Band 8. Kiel 1905.

plainly shown, so far as the northernmost part is concerned, by the boundary line between this water and the East Icelandic Polar current) until in the Faroe-Shetland Channel it again turns in a more northerly direction.

## Sections VII, VIII, IX.

Section VII which was taken in the beginning of June from the Hebrides towards the west to about the middle of the Rockall Channel of course shows somewhat mixed water nearest the Hebrides (St. 55); yet the salinity is 35·25 ‰ in the surface, but decreases a little with the depth, which is the reverse of what is usually the case in coast water and which therefore indicates that the unmixed water toward the west is making inroads on the coast water. Its temperature is somewhat lower than the temperature of the unmixed masses of water at the same depth farther west, and on the whole this also seems to be the case with those masses of water that are found over all the coast shallow, which indicates that this water still retains a trace of the winter conditions (cf. p. 12). Since the specific gravity at St. 56 at a depth of 150 meters is just as great as that found at St. 58 at a depth of 800 meters (of course not considering the compression), the former masses of water have a tendency to sink down the slopes of the shallow until they reach the latter depth.

The salinity in the surface water is about 35·40 ‰ outside of the area influenced by the coast water; yet in the westernmost part of the section it is again somewhat lower (35·31 ‰), but at a depth of 100 meters it reaches the former figure. From this we see that here too we have a rather narrow strip of salter water in the surface analogously with what is the case between the Faroe Islands and Shetland; which leads us to conclude that the strip with higher salinity that is found at the latter place has not been formed in the Faroe-Shetland Channel by mixture with less saline water from both sides, and that the direction of the surface current from this section and further toward the northeast will mainly be determined by the direction of this strip with the high salinity.

Section VIII extends about in a northern-southern direction from about 58° to 50° N. Lat.; the three Stations 58—60 are taken at depths of 1400—2000 meters and are by means of the shallow west of Ireland separated from the two Stations 65 and 70 south of the shallow which have greater depths. We shall therefore first consider the northern part. Both isotherms and isohalines sink deeper toward the south, which may be partly due to the fact that St. 58 lies a little bit farther out in the Rockall Channel, in the easternmost part of which the warmest water is perhaps to be found. However if we compare the conditions here with those in the basin south of Iceland we immediately see a considerable difference. There we found 7° isotherm at a depth of about 800 meters, but here we find at this depth the 8°5 isotherm; but analogously with what was the case south of Iceland the variation in temperature from the surface to this depth is extremely little; the temperature is over 8° to a depth of almost 1000 meters but from here it decreases almost 1° per 100 meters until it reaches 6° at a depth of a little over 1200 meters, whereupon it again decreases somewhat more slowly and is 5° at a depth of 1400—1500 meters, 4° at about 1700 meters and is still 3°5 C. at a depth of 1900 meters. Thus the temperature at depths less than 1500 meters is on an average 1°5 higher than at the same depth south of Iceland, and the corresponding isotherms here lie about 300 meters deeper than there; also near the bottom at a depth of 1900 meters the temperature here is somewhat higher even if it is not so much so as in the upper layers, and this higher temperature in the bottom water is on the whole quite natural since this water is cut off from any connection with the water south of Iceland by means of the more shallow part constituting the Rockall-Faroe Bank, so that the bottom water found here must have been conveyed hither south of the Rockall Shallow.

The salinity is also somewhat higher than in the basin considered above — about 35·40 ‰ in the surface, and the 35·35 ‰ isohaline lies at a depth of about 900 meters; in those masses of water whose temperature is under 8° the salinity has about the same value as that which corresponds to the respective temperature south of Iceland; but since, when the temperature has sunk under 8°, it rapidly decreases with the depth, the same is consequently the case with the salinity. Only in the layer nearest the bottom do we find in connection with somewhat higher temperature the same value (35·00 ‰) for the salinity as that which was found at the same depth in the basin considered above, and since we have seen that the bottom water here must have been conveyed hither south of the Rockall Shallow, we may conclude from this that the salinity of the bottom water must be pretty constant throughout the whole of the North Atlantic Ocean and equal to 35·00 ‰.

The surface temperature of course increases toward the south and this increase continues over the shallow west of Ireland although the conditions there are rather variable owing to the greater or less influence exerted by the coast-water; the southernmost Station on the shallow (St. 64), however, shows exactly the same peculiarities as the two Stations 65 and 70 south of the shallow, which on the whole present points of interest. Thus we find here temperatures which are about just as much higher than the corresponding ones north of the shallow as these were higher than the temperatures at the same depths north of the Faroe-Bank, and this higher temperature is found all the way down through the whole layer of water so that the isotherms lie 200—300 meters deeper than the corresponding ones on the northern side of the shallow; for instance if we take the 7° isotherm, then south of Iceland it lay at a depth of about 800 meters, in the Rockall Channel between the Faroe Bank and Ireland a little over 1100 meters and south of the outer bank west of Ireland at a depth of about 1300 meters, and similar deviations are found for the rest.

The higher value of the surface temperature in the southern part of the Section is partly due to the lower latitude and partly to the fact that the southernmost observations were taken later in the season so that the summer warmth had got greater influence. The higher salinity in the surface is obviously closely connected with these conditions of temperature; for instance at St. 70 the salinity in the surface is 0·08 ‰ greater than at a depth of 100 meters; for the warmer air can absorb greater quantities of vapor and the greater evaporation from the surface will increase the salinity of the surface water, but we see from the specific gravity in the surface layer that the effect of the warming, which is a tendency to diminish the specific gravity, far exceeds the opposite tendency which is the effect of the evaporation and consequently it is impossible for the evaporation to produce convection through an increase of the surface salinity and the specific gravity, as is often the case in seas over which the air is very dry, for instance in the Red Sea.

However it is not only in the surface that the salinity is greater than in the Rockall Channel, but this is the case at all those depths where observations have been taken, the least value of the salinity being 35·44 ‰; moreover we find here strangely enough that the salinity from a certain depth increases with the depth and even reaches the value 35·55 ‰ at 1000 meters. Since this difference in salinity 0·11 ‰ is at least 5 times as great as the observation-error, and since the two Stations 65 and 70 show the same conditions, which by the way are also found at St. 69 (Section IX), there is accordingly no doubt that such an increase of salinity with the depth is really to be found, a case which is very different from what we are accustomed to find in the warm Atlantic current; there the salinity is usually constant in a great layer, or when it increases with the depth this is the case only in a thin layer nearest the surface and then we can always show that the surface water has become thinned either by mixture with coast water or with less saline masses of water from adjacent currents.

Now we might ask about the reason for this increase of salinity with the depth. Since the salinity certainly does not begin to increase until below a depth of 400 meters and probably not until below a

depth of 800 meters it is obviously not dependent upon either of the two factors mentioned, since neither these exists at such a depth; of course the uppermost 800 meter layer of water might have become somewhat thinned on its way over the Atlantic Ocean and this process might not have reached down to a depth of 1000 meters, but then we should expect to find similar conditions in the Rockall Channel north of Ireland, which, as we have seen, is not the case. If we now consider the masses of water in the Bay of Biscay, we know that they have a high temperature throughout a far greater layer than is apparent from our observations, as was already shown in 1869 by the English Porcupine-Expedition[1]); besides the case is the same along the coasts of Portugal and North Africa, as was shown by the "Challenger-Expedition" in 1873. Wywille Thomson[2]) thought that these warm masses of water, which in bulk exceed those that are found off the Gulf of Mexico, were due to a piling op (German: Wasserstau) of the warm masses of water which as a continuation of the Gulf Stream are cast against the coast of Europe, whereby they are stopped in their movement and forced to find a way down. F. Y. Buchanan[3]) and Alexander Buchan[4]) gave a different explanation of the origin of this great layer of water, which was mainly based on hydrometer measurements; they held that it was the product of a mixture of the water of the Atlantic Ocean with an undercurrent coming from the Mediterranean Sea through the Strait of Gibraltar; the latter having a high temperature and a high specific gravity sinks down and increases the bulk of the warm water.

From the point of view that the huge warm masses of water in the eastern part of the Atlantic Ocean originate through mixture with the warm masses of water from the Mediterranean Sea, it is easy to explain the peculiar conditions in the salinity at St. 65 and St. 70, for then the higher salinity at a depth of about 1000 meters is due to some influence, however little, of the salt masses of water flowing out from the Mediterranean Sea. Out from the theory that the huge warm layer of water has originated by the piling up of the water, the peculiar conditions in the salinity are not to be explained, because such a maximum of salinity cannot arise unless we assume that the salinity both in the upper and in the lower layer is a periodical function of the time. Let us for instance assume that the salinity in the surface is greatest in the winter when the temperature is lowest; when the surface water sinks down and is replaced by warmer and less salt masses of water, the conditions that we have found might thus have been brought about, but since of course the same process would continue, these salter masses of water would again be replaced by others with lower salinity which have been forced to sink down and the salinity at greater depths would thus be subjected to periodical variation, and this would in the first place be improbable and in the second place it would be difficult to imagine how the warm masses of water could be forced down in the summer. If this maximum of salinity were to fit into the piling up theory we should have to fall back on such a device as an undercurrent from more southern parts where the salinity of the sinking masses of water is higher, but since the observations of the Challenger-Expedition off the coasts of Portugal and North Africa also show an increase of salinity with the depth we must reject the piling up theory and seek an explanation of the origin of this layer of water in the undercurrent of warm masses of water with very high salinity (temperature at least 13° C., salinity 37—38 ‰) that flow out from the Mediterranean Sea through the Strait of Gibraltar.

The conditions here described, which are found at the Stations 65 and 70, are found in a still more marked degree at St. 69, which was taken somewhat farther toward the east and a little farther south than these two; here the salinity is still higher — highest at a depth of 1000 meters where it is equal

[1]) Proceedings Royal Society. Vol. XVIII, p. 397, 1869.
[2]) Wywille Thomson: The Voyage of the "Challenger". The Atlantic. A Preliminary Account etc. London 1877.
[3]) Scottish Geographical Magazine 1888, p. 194 ff.
[4]) Alexander Buchan: Report on Oceanic Circulation. "Challenger"-Reports. Summary of Results. Vol. II, App. 8.

to 35·64 ‰ — and considering the increase with the depth it is possible that the maximum of salinity here in the Bay of Biscay is to be found deeper than 1000 meters. The temperature is also somewhat — on an average 0·6—0·7 — higher than at the same depths at the two Stations farther west, but unfortunately we have here no Stations at so great a depth that it gives us a lower limit for the warm layer of water and the transition layer to the bottom water, but with regard to the temperature, the Porcupine's St. 38, which is taken a little farther south at a depth of 2090 fathoms, may be considered typical.

This decrease in temperature and salinity from Station 69 to Stations 65 and 70 is a natural result of the fact that the latter two lie farther from the Strait of Gibraltar than the former, since of course the masses of water are on the way subjected to cooling and mixture with other water, and this process will be continued some distance out in the Atlantic Ocean; farther out in the ocean these masses of water with the maximum of salinity will meet water with lower salinity than that found in the layers above them and by mixing with this the maximum of salinity will gradually disappear. Since these masses of water whose origin is partly to be traced to the Mediterranean Sea are even at about 12° W. Long. south of the outer bank west of Ireland conveyers of a distinct maximum of salinity in connection with high temperature, we cannot, as G. Schott[1]) does, reject the idea, that they also might exert some influence on the masses of water in the northern part of the Atlantic Ocean; for with an expansion of only 150—200 miles toward the west they would be conveyed with the current up through the Rockall Channel, and although we cannot show any maximum of salinity in the depths of this channel north of Ireland, yet it is highly probable that the great bulk of warm and salt water found there is due to nothing else but the expansion of those masses of water that characterize the eastern part of the Atlantic Ocean outside of the outlet of the Mediterranean Sea.

On the coast shallow south of Ireland (Section IX), we find under the layer that has been subjected to the influence of the atmosphere a layer of water in which both the temperature and the salinity are quite constant in a vertical direction, but both decrease towards land where the values at St. 66 are respectively 9°64 and 35·28 ‰; there is scarcely any doubt that this layer of water has remained here since winter or early spring because the constant temperature shows that it has been cooled by convection. The English observations[2]) in the western part of the Channel also show that the temperature there in the winter is of about the same value as that found here, namely 9°—10°, and in May the conditions observed at the English stations are similar to those found here, the temperature being constant in a layer from the bottom up and increasing only from a depth of 30 meters to the surface, probably in the main owing to warming from the atmosphere.

When we observe that as far north as west of the Hebrides (Stations 56—58) already fourteen days earlier we have higher temperature at a depth of 50 meters than at St. 66 south of Ireland although there are much warmer masses of water toward the south and west, then we can conclude from this that the current over this coast shallow south of Ireland flows slowly in comparison with the speed of the current west of the island or even that the current perhaps does not flow in an eastern direction. From English observations[3]) it appears that the fresh water from the Irish Sea spreads toward the south over the English Channel, a circumstance which makes it seem probable that all around Ireland there flows a current in an anticyclonic direction, a case which is found almost everywhere (the East-Greenlandic polar currents bend at Cape Farewell, the eastern branch of the Irminger current, the current north of Scotland toward the south into the North Sea etc.), and thus it

[1]) G. Schott: Ozeanographie und Maritime Meteorologie. Wissenschaftliche Ergebnisse der deutschen Tiefsee-Expedition auf dem Dampfer "Valdivia" 1898—99. Band I, p. 188. Jena 1902.

[2]) Bulletin des résultats etc.

[3]) Donald J. Matthews: Report on the Physical Conditions in the English Channel 1903. Marine Biological Association Report I, 1902—1903, London 1905.

seems probable that the less saline masses of water which are found nearest the bottom over the coast shallow have originated from the fresher water from the Irish Sea.

The last mentioned observations west and south of the British Islands were taken on an expedition the chief aim of which was to investigate the propagation of *Leptocephalus brevirostris*, the fry of the fresh-water eel. The reader is referred to Dr. SCHMIDT's article[1]) about this matter; we shall only mention briefly here that in the summer of 1904 a specimen was caught north of the Faroe Bank (about at St. 122) and that on the expedition of 1905 already mentioned several were caught at and south of Station 57 and that the number seemed to be about the same over all the stretch north of Ireland while south of the outer bank west of Ireland the number was several times greater in hauls of the same length. This seems to indicate that these eel-larvae are extremely rare north and west of the Faroe Bank, more frequent south of this bank in the Rockall Channel, but even here much rarer than south of the outer bank west of Ireland. Moreover these larvae seemed to occur in the upper layers of water over certain depths whose minimum was 1000 meters; the explanation of this given by JOHS. SCHMIDT is that the eel cannot reach puberty or at any rate cannot spawn except when under a strong pressure, and that the spawning cannot take place at all when the pressure does not exceed a certain minimum value, which to judge by the depth over which the larvae were found may be estimated at 100 atmospheres (corresponding about to a pressure of about 1000 meters of water). Further it is probable that the eel just like most other kinds of fish only spawn when the temperature of the water exceeds a certain minimum value and assuming this to be the case we can now get an idea about this temperature. South of Iceland the temperature is at a depth of 1000 meters about 6° — generally a little under — while farther east, especially on the northern side of the Faroe Bank, it is somewhat higher — about 7° — and since the larvae here are extremely rare, it seems probable that here we approach the lowest temperature at which spawning can take place, and the minimum temperature can thus be established at about 6° C.

South of the Faroe Bank in the eastern side of the Rockall Channel the temperature at a depth of 1000 meters is only a little under 8° C. and the temperature is on the whole, as we have seen in Section V and VI, somewhat higher than at the corresponding depths north of the Faroe Bank; these masses of water with the higher temperature probably furnish better conditions for spawning and hence the more numerous eel-larvae found here. The reason why considerably greater numbers of Leptocephalæ were found on the southern side of the outer bank west of Ireland than on the north side is then to be sought in the fact that here again we have a sudden change of temperature; the temperature being somewhat higher than in the places formerly mentioned — for instance 8·6—8·8 at 1000 meters and over 7° to a depth of about 1300 meters — and that the warmer masses of water which are found here at those depths where the spawning takes place furnish better conditions of life for the spawning eel and probably also for the fry than the colder masses of water farther north. Now since the Bay of Biscay down to a considerable depth, as likewise the eastern part of the Atlantic Ocean off the west coasts of Portugal and North Africa, are filled with such warmer masses of water, it is probable that in these places where we have the great pressure and the high temperature the spawning places of the eel are to be found; yet the fact that the coast shallows here generally go very steeply down to the great depths is probably also a factor of importance, since then the belt with depths suitable for the spawning eel is often very narrow. The variations in salinity can scarcely be supposed to have any influence upon the spawning of the eel since the greatest variation in the places mentioned here scarcely exceeds 0·5 ‰ i. e. 1·4 % of the whole amount of the salinity.

[1]) JOHS. SCHMIDT: Contributions to the Life-History of the Eel. (Anguilla vulgaris). Rapports et Procès-verbaux. Vol. V, Copenhague 1906.

## Summary.

To sum up briefly the results of these investigations, and beginning at the north with the basin south of Iceland, we have shown constant salinity (about 35·25 ‰) in the uppermost layer of water of about 800 meters' thickness where the temperature, with the exception of the surface layer which is warmed up by the atmosphere in the summer, varies but little in a vertical direction (between 8° and 7°), and where the variation in temperature in a horizontal direction is extremely little. Since those observations which were taken in the very beginning of the spring show quite constant salinity in a huge layer, and since the variation of the temperature with the depth is less than later in the summer, we conclude that in this huge layer of water there are in the winter convection-currents, which cause constant temperature and salinity. However we have no measurements of temperature that show such a constant temperature although this may be due to the fact that even the earliest measurements were taken some time after the convection has ceased, after which new masses of water in part had been conveyed thither from more southern latitudes and caused a somewhat higher temperature; supposing the speed of current to decrease with the depth, then such an afflux of water would give us exactly such a state of conditions in which the temperature decreases with the depth and this decrease would depend upon the length of time that had passed since the convection had ceased. In how far this layer of water increases in thickness in the course of the summer it is impossible to decide on the basis of the material at hand and likewise we cannot give the exact amount of the yearly variation in temperature, but the mean variation is probably about 0°5 in the layer from 100 to 800 meters.

The surface temperature which is 7°—8° during the coldest season of the year rises in the course of the summer to about 12° as a result of the warming influence exerted by the sun and the atmosphere, and at the same time the less saline masses of water which are found on the west side of the warm current spread out over the whole area in a thin surface layer, which gradually mixes with the salter water and thereby lowers the salinity a little down to a depth of about 100 meters; yet this lower value for the salinity does not amount to more than 0·1—0·2 ‰ under the normal surface salinity, and it is found on a line Faroes—South Iceland in September—October. So this lower salinity is only found in a comparatively thin layer and consequently cannot furnish us with any reliable basis for conclusions regarding changes in the force and extent of the Atlantic current.

The intervening layer between this huge warm layer of water with the little variation in tempeture and the bottom layer where the variation in temperature again is small (i. e. the layer where the temperature decreases from 7°—4°) varies in thickness according to the depth; when the depth is about 2000 meters the thickness of the intervening layer is 500—600 meters, but especially in smaller depths in the eastern part of the basin it is very thin.

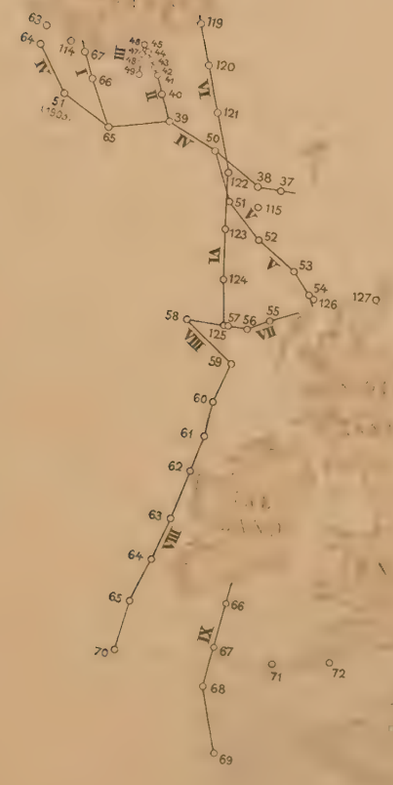
The bottom layer itself has a temperature of about 3° and a salinity of about 35·00 ‰; the temperature is somewhat lower over toward the ridge from the Faroe Islands to Iceland, especially over toward the western part of the ridge, and since this lower temperature (1°—2°) is also found at relatively little depths we see from this that a cold bottom current shoots down from the north over the ridge. On the whole however the warm water goes a little bit deeper in the eastern part of the basin than in the western part over toward the Reykjanæs-Ridge, from which we conclude that the supply of cold bottom water that comes from the west (Denmark Strait, the Labrador current) outweighs that which comes over the Faroe-Iceland Ridge.

The Faroe Banks seem to form a boundary between the masses of water which flow east and west of the Rockall Shallow; for on both sides of the newly discovered Faroe Banks there are marked differences both in temperature and salinity, which indicates that there is no very strong current through the channel between Rockall and the Faroe Bank (from Section VI, Station

123, however, it appears that the surface layer with the somewhat lower salinity spreads toward the east north of Rockall). When such an exchange does not take place we conclude that the masses of water which flow up through the Rockall Channel between Scotland and Rockall run out over the Wyville Thomson Ridge east of the Faroe Banks, while the masses of water which are found north of these banks and which have come west of Rockall flow partly over the Faroe Shallow, partly over the Faroe-Island Ridge and from there toward the east north of the Faroe Islands.

South of the Faroe Banks in the Rockall Channel the salinity is somewhat higher than north of the Banks, and the case is the same in an even greater degree of the temperature; thus the isotherms here lie 200—300 meters deeper, and even at the greatest depths the temperature is somewhat higher, the bottom water that flows in south of the Rockall Shallow being about $^1/_2°$ warmer than that which is found at the same depth south of Iceland. The salinity and the temperature remain about constant in a horizontal direction down toward Ireland, but south of the shallow that extends from this island toward the west we again find a change in temperature similar to that over the Faroe Bank, the isotherms here being again found 200—300 meters deeper than the corresponding ones in the Rockall Channel. The salinity has also increased and has now a marked maximum at a depth of about 1000 meters. Since, according to the Challenger's observations, similar conditions in the distribution of salinity are found in the eastern part of the Atlantic Ocean off the Strait of Gibraltar, the reason for this must be sought in the warm and salt masses of water which as an undercurrent make their way from the Mediterranean Sea through the Strait of Gibraltar, and here too is to be found the cause of the high temperature in this part of the Atlantic Ocean, which at depths of 600—2000 meters is higher than in the rest of the Atlantic Ocean and on the whole higher than any other place in the open sea with the exception of the northern part of the Indian Ocean (between India and Arabia where, according to G. Schott, analogous conditions have given rise to the higher temperature from 150—3000 meters). As these masses of water, which have partly come from the Mediterranean Sea, spread out, they mix with the colder Atlantic water, in which they gradually get lost; however it is probable that the warm layer of water found in the Rockall Channel owes its great bulk to a mixture with these masses of water that have been influenced by the Mediterranean Sea, the mixing process being so far advanced that the characteristic salinity maximum has disappeared.

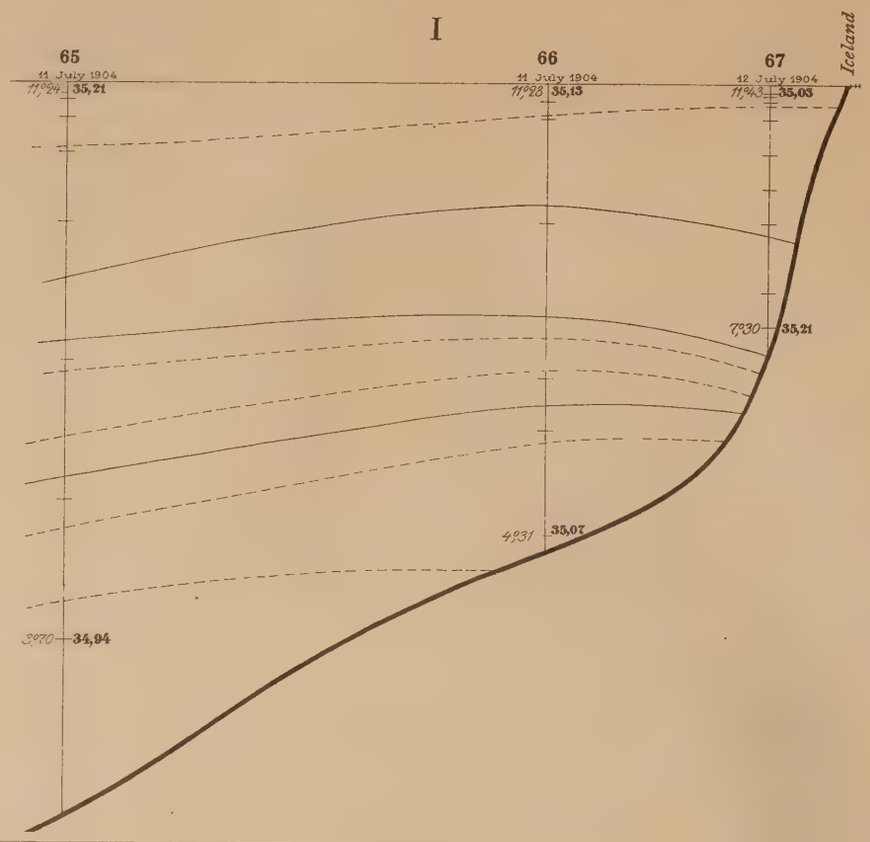
Over the coast shallow south of Ireland, there is found in June a layer from the surface to a depth of only about 35 meters with the high temperature corresponding to the season of the year, and there is a very sharp line of division between this layer and a bottom layer whose temperature is constant in a vertical direction — nearest land under 10° — and a salinity of 35·26—35·32 ‰ which shows partly that this layer of water has been here a long time — from the winter or early spring when the surface water cooled off and the convection currents prevailed — partly that it has been influenced by fresher coast water, probably from the Irish Sea, which, according to Donald J. Matthews, sends its fresher masses of water down to the English Channel. The fact that such fresh masses of water are also found south of Ireland makes it seem probable that the north-going current west of Ireland sends a branch around the north coast of the island and down through the Irish Channel, so that this island has a coast current in an anticyclonic direction like Iceland, Scotland etc.; this will probably soon be definitely decided through the elaborate hydrographical investigations which have now gone out from Ireland.

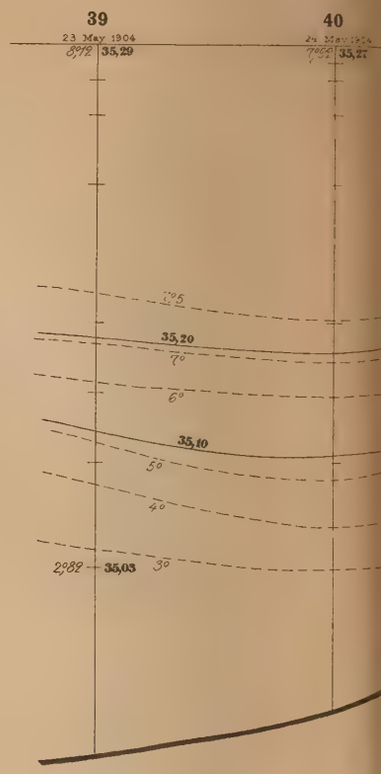


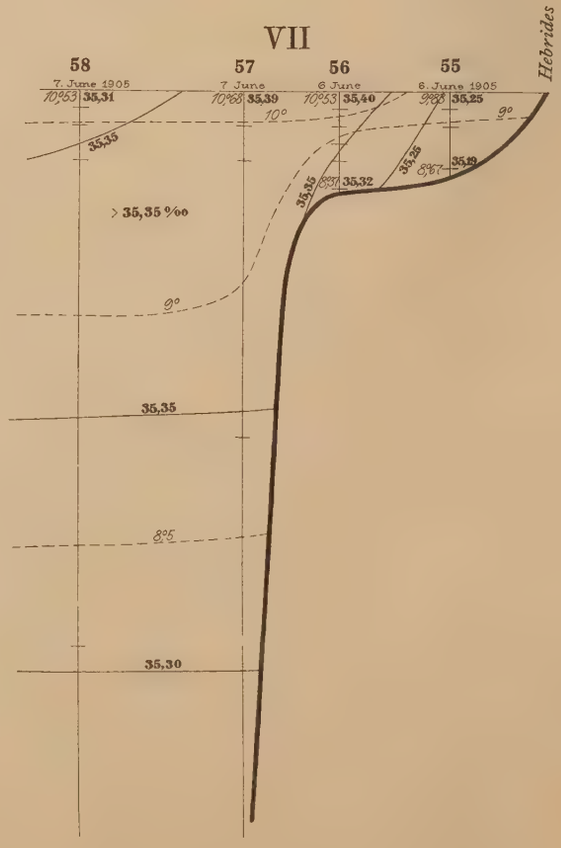


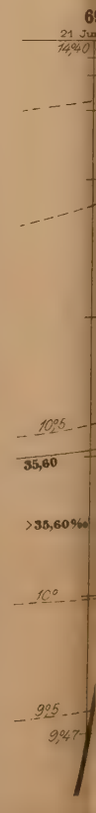

## Stations and Sections

1904 and 1905.



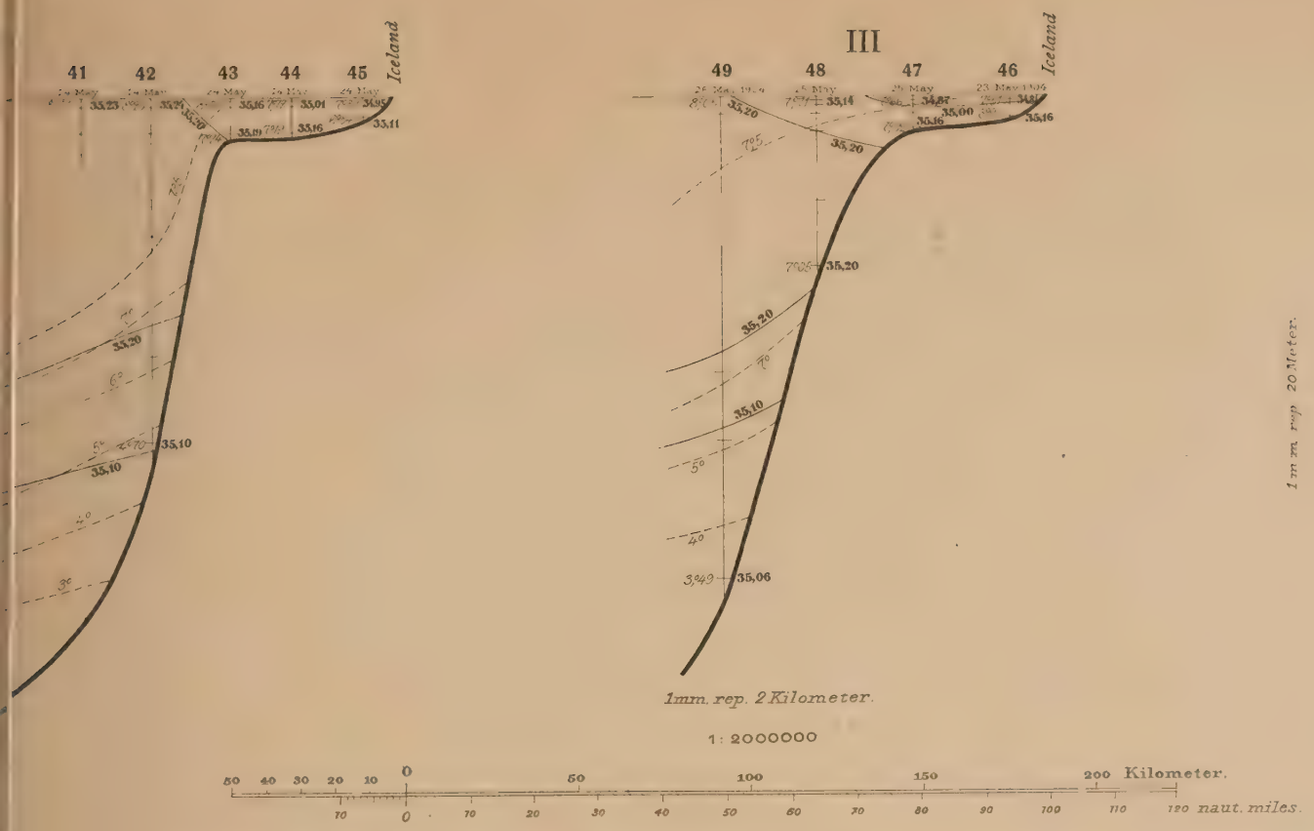




Curves of equal Salinity.
Curves of equal Temperature.

*A horizontal side line to the left of a vertical line at a station, represents an observation of temperature; one to the right an observation of salinity.*




1mm. rep. 2 Kilometer.

1 : 2000000

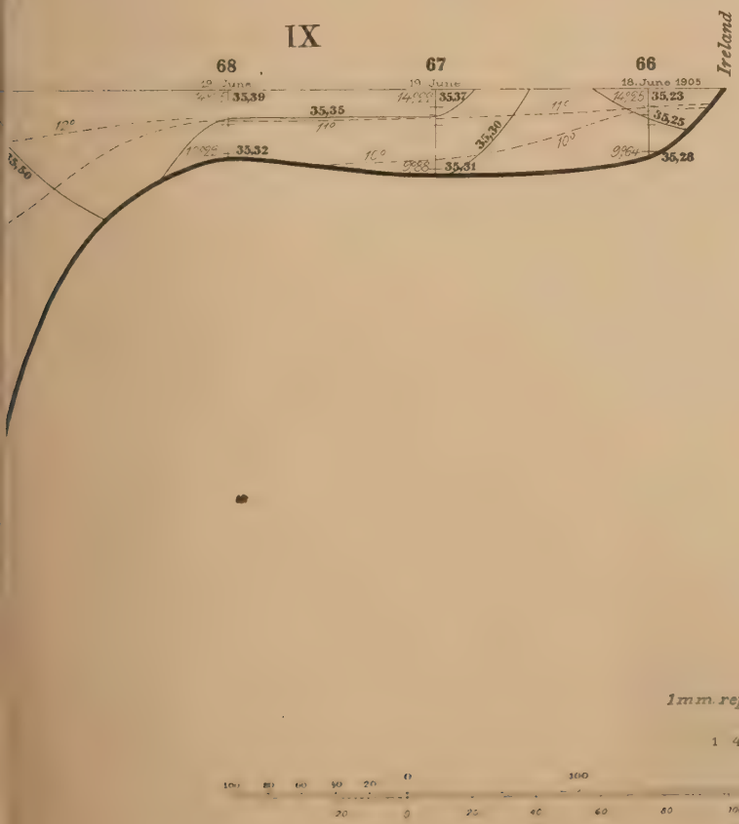
50 40 30 20 10 0 50 100 150 200 Kilometer.

70 0 10 20 30 40 50 60 70 80 90 100 110 120 naut. miles.

1 m. rep. 20 Meter.

fathoms 0 Meter

1 : 20000.




1mm. rep. 4 Kilometer.

1 4000000

100 80 60 40 20 0 100 200 300 400 Kilometer

20 0 20 40 60 80 100 120 140 160 180 200 220 240 naut. miles

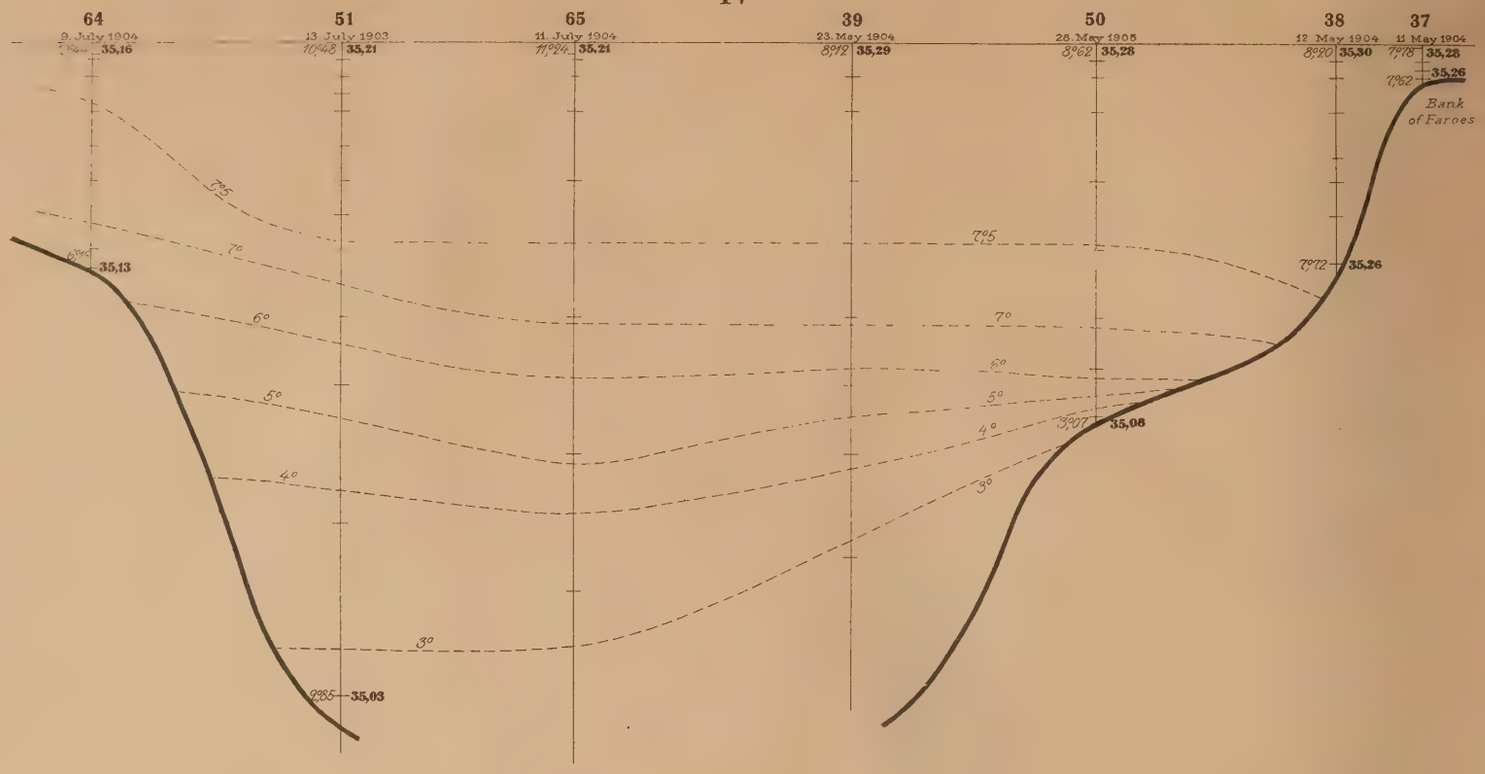
1 m. rep. 10 Meter.

fathoms 0 Meter

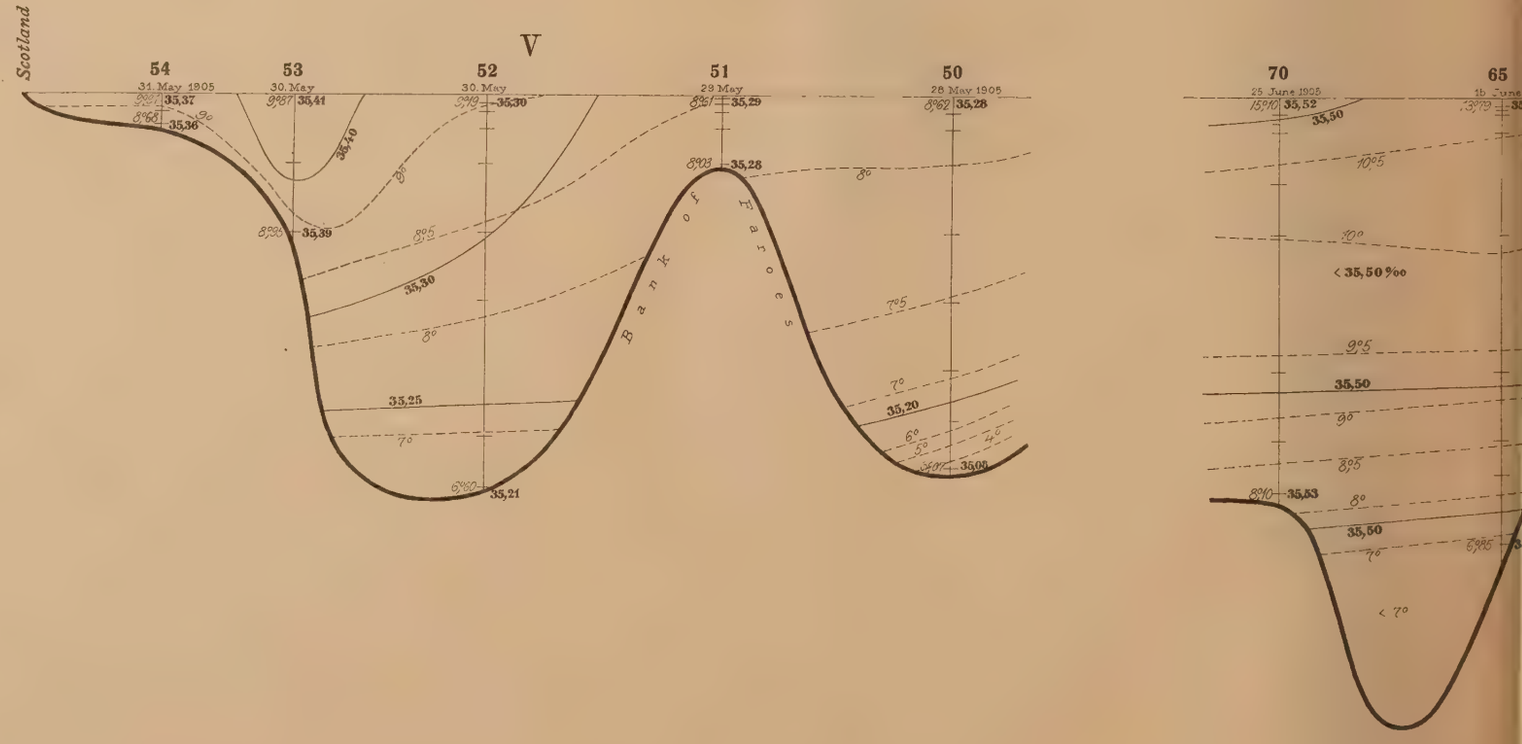
1 : 10000.

Aml. Lithodt. Etabl. Khvn

## IV



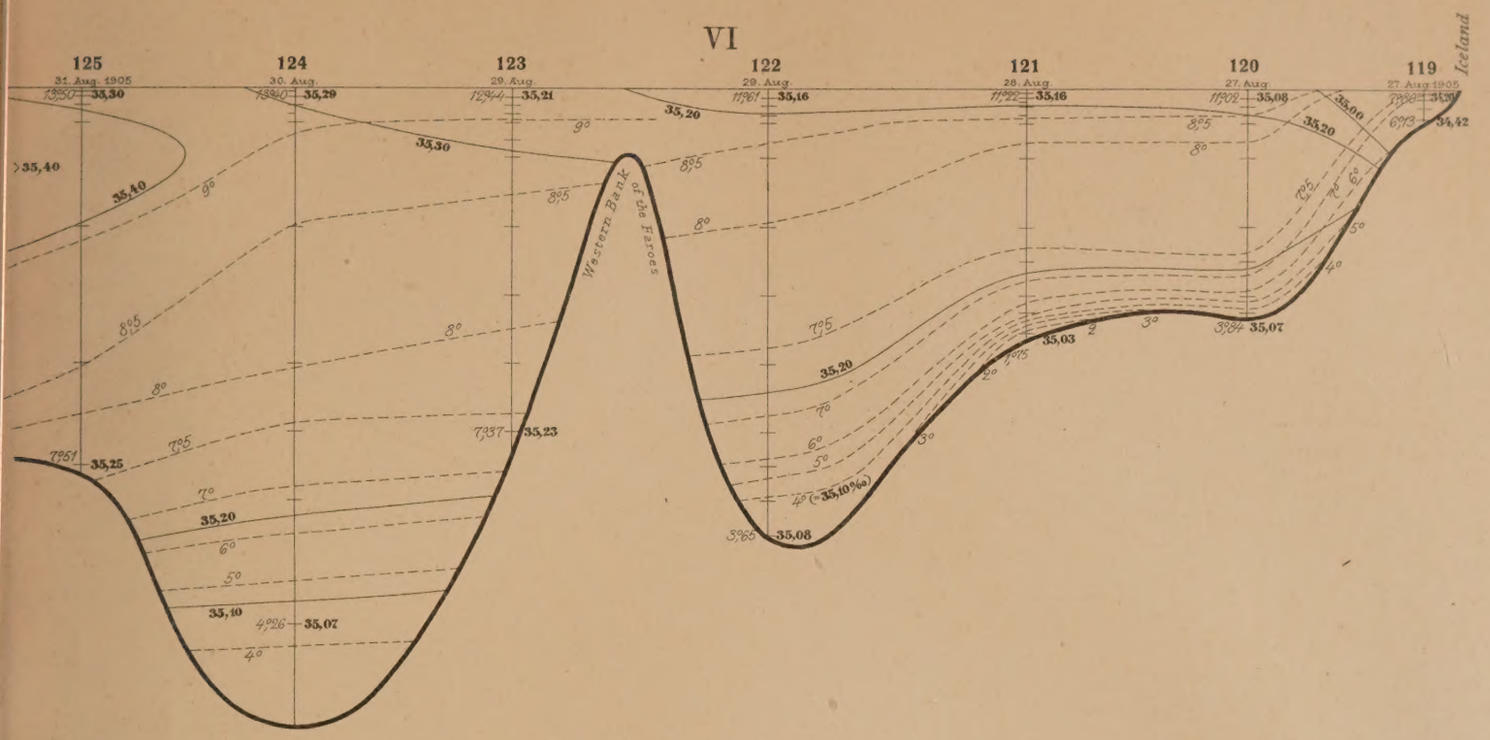

## V

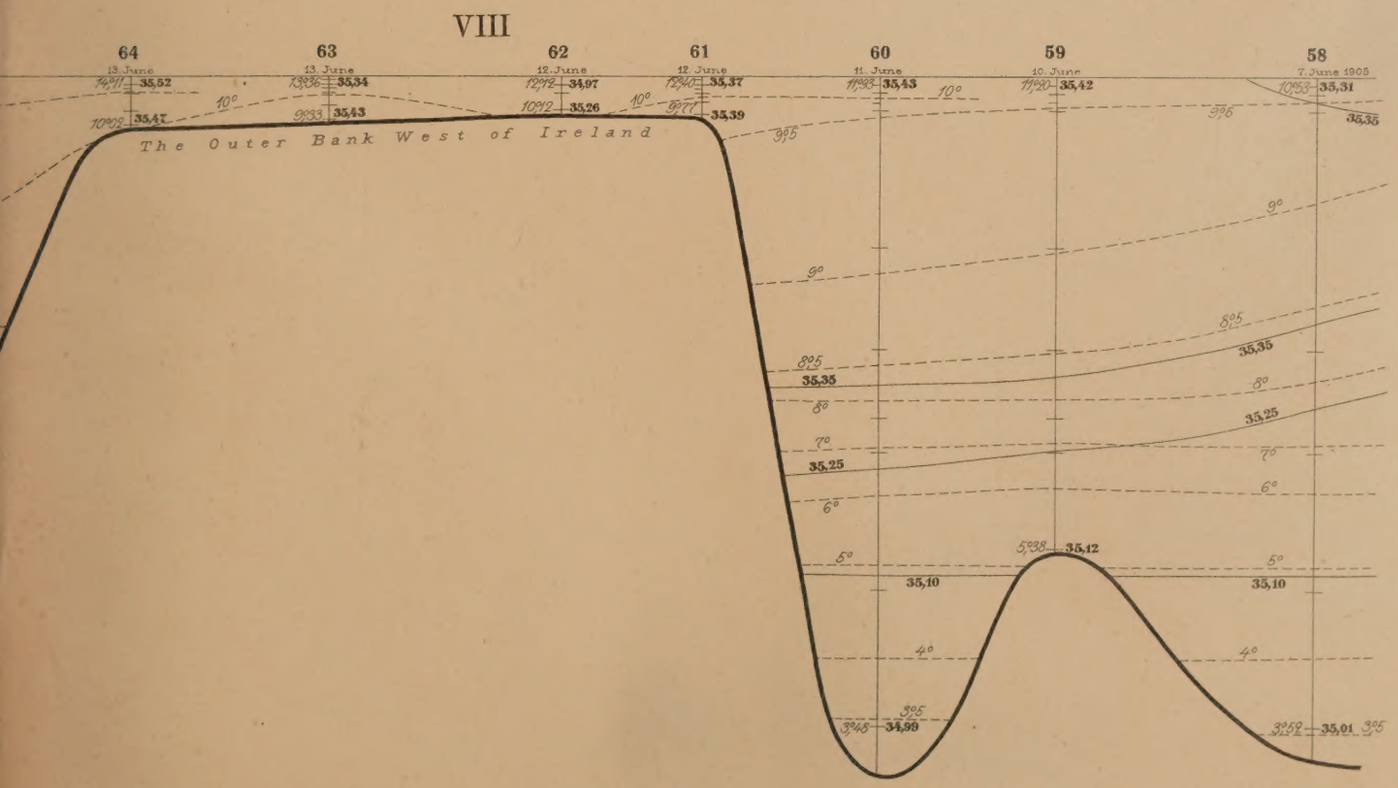



*Curves of equal Salinity.*

*Curves of equal Temperature.*

*A horizontal side line to the left of a vertical line at a station, represents an observation of temperature; one to the right an observation of salinity.*




Axel Aamodt lith. Etabl. Kbhvn.

0 100 200 300 400 Kilometer

1: 4000000

20 0 20 40 60 80 100 120 140 160 180 200 220 240 naut. miles

1 m m rep. 20 Meter. 1:20000.